April 2007 Applied Mathematics Eng-13 Course Works

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April 29, 2007, rev 0.10

1 Introduction

This document is intended to provide detailed instructions for 2007 Department of Applied Mathematics course works. While the contents of this section apply to all of the course projects, the following sections cover individual tasks. However, it is highly recommended for everyone to read the document in its entirety.

Read the paper hydrosim.pdf provided earlier, paying special attention to the contents of Sections 3-6. Any questions can be addressed either to me by email or posted under the "Industrial and Applied Mathematics Seminar" Board at *http://www.azsociety.net* Forum. Register with the Forum unless you have already done so.

Provided herewith are LaTeX templates for your course papers - one for the main body of the paper, and one for the bibliographic database. The files are named paper.tex and paper.bib, respectively. Use the following command sequence on Unix system (or its **MixTeX** equivalent on Windows):

```
#latex paper
#latex paper
#bibtex paper
#latex paper
#latex paper
```

to produce *paper.dvi* output file (pdflatex can be used instead of latex to generate PDF output). View it with xdvi or its **MikTeX** equivalent.

The initial bibliograpic database paper.bib shall be identical for all papers. Whenever a citation is required of hydrosim.pdf, put in the following reference [3]:

```
\cite{Maharramov00}.
```

Each work should state the following as the overall project objective in its Preamble or Introduction:

> This work is part of the **On-line Pipeline Hydraulics Simulator** Project (*http://www.appliedmathematics.org/hydro/*). The overall objective of this Project is to transform the existing hydraulic simulations software presented in [3] into a web-enabled application and implement additional enhancements in terms of both core functionality and interface. This work is closely related to other research works performed as part of the overall Project, and it must be read in conjuction with them and paper [3]. Crossreferences in the project documentation will assist in establishing the required dependencies.

This is intended to be a living document that will be continuously updated to provide instructions to the Project Team.

2 Electra

- Title: *A Mathematical Model of a Steady State Flow of a Viscous Liquid.*
- Use the provided paper.tex and paper.bib as templates for your paper.
- Put a description of the Project in the introductory section as directed above. Indicate the derivation of alternative mathematical models of pipeline hydraulics as the specific purpose of your work.
- In Section 1, put a conceptual description of a hydrocarbon pipeline as a physical system along the lines of [3], Section 3.
- In Section 2, put a description of the mathematical model studied earlier as per [3], Section 4. Provide a very detailed description of how Eq (22) is derived from (3) and Eq (25) from (7).
- In Section 3, derive explicit expressions for $\lambda(i)$ approximating Eq (24), using linear and/or quadratic approximation to the right-hand side.
- In Section 4, provide formulae for evaluating p and T from Eqs (22) and (24).
- Further work will require input from others ...

3 Mickey

- Title: *Fast Algorithms for Solving Non-linear Algebraic Equations.*
- Use the provided paper.tex and paper.bib as templates for your paper.
- Put a description of the Project in the introductory section as directed above.

- In Section 1, put a conceptual description of a hydrocarbon pipeline as a physical system and the corresponding mathematical model along the lines of [3], Sections 3 and 4. Specifically mention Eq (24) and methods for its approximate solution as being the main subjects of your work.
- In Section 2, provide a description of approximate solution techniques for solving nonlienar algebraic equations including at least simple iteration, secants and Newton linearisation. Use [1] and [4] for reference (the latter is available on-line at *http://www.nr.com/nronline_switcher.php*)
- In Section 3, develop an algorithm similar to Newton's linearisation but based on using both first and second-order derivatives of the right-hand-side function. In other words, at each iteration of Newton's algorithm, expand the right-hand side of Eq (24) using the 2-nd order Taylor expansion and solve the resulting quadratic rather than linear equation.
- Further work will require input from others ...

4 Hussein

- Title: *Modelling Turbulent Flows in Steel Pipelines*.
- Use the provided paper.tex and paper.bib as templates for your paper.
- Put a description of the Project in the introductory section as directed above. Indicate the development of a back-end computing module for simulating pipeline hydraulics as the specific purpose of your work.
- In Section 1, put a conceptual description of a hydrocarbon pipeline as a physical system and the corresponding mathematical model along the lines of [3], Sections 3 and 4. Specifically mention that porting the existing application codes listed in [3] Appendices to a back-end compiled C or Fortran programme as being the main purpose of your work.
- In Section 2, describe the data structures declared in C or Fortran repersenting the product and ambient temperatures, elevation, head, pressure, pipeline overall diameter, wall thickness, tensile strength, wall roughness, and product characteristics. These declarations should be compatible with those of the existing application as decsribed in Appendix A.
- In Section 3, translate [3] Appendix B codes into C or Fortran. Reference [5] and [2] as necessary.
- Further work will require input from others ...

5 Miamski

- Title: *Platform-independent Web Interface for Modelling Hydrocarbon Pipelines.*.
- Use the provided paper.tex and paper.bib as templates for your paper.
- Put a description of the Project in the introductory section as directed above. Indicate the development of a web interface to the back-end simulation module developed by others as the specific purpose of your work.
- In Section 1, put a conceptual description of a hydrocarbon pipeline as a physical system and the corresponding mathematical model along the lines of [3], Sections 3 and 4. Specifically mention porting to the web of the existing application described in [3] as being the main purpose of your work.
- Write a Java servlet and a matching applet for feeding an arbitrarily large array of floating point numbers through a web interface and storing the data in a text file on the web server.
- Further work will require input from others ...

References

[1] N. S. Bahvalov, N. P. Jidkov, and G. M. Kobelkov. *Numeric Methods (in Russian).* Nauka, Moscow, 1987.

[2] Stephen J. Chapman. *Fortran 90/95 for Scientists and Engineers.* McGraw Hill Higher Education, 2004.

[3] M. Maharramov. Mathematical modelling of a steady-state flow of a viscous liquid in a pipeline. http://www.maharramov.com/cgi-bin/load.pl?ID=24.

[4] William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery. *Numerical Recipes in Fortran 77. The Art of Scientific Computing.* Cambridge University Press, New York, NY, second edition, 2003.

[5] Bjarne Stroustrup. *The C++ Programming Language.* Addison-Wesley, 1997.