Designing Projects for Engineering Mathematics Students

Jeremy L Thompson

United States Air Force Academy

jeremy.thompson@usafa.edu

April 9, 2015

Overview

Projects are often an important component in mathematics courses for engineering students. In this talk, I discuss a series of projects I designed for two courses, Calculus III and Engineering Mathematics (Systems of DEs and Introduction to PDEs). I focus on project goals and where these projects appeared to do well or fall short.

Overview

1. Background
2. Projects
3. Lessons Learned

Engineering Math at USAFA

Engineering Math Sequence

1. Calculus I (differential calculus)
2. Calculus II (integral calculus)
3. Calculus III (multivariate and vector calculus)
4. Differential Equations
5. Engineering Mathematics (systems of DEs, PDEs, numerical methods, vector calculus)

Engineering Math at USAFA

Engineering Math Sequence

1. Calculus I (differential calculus)
2. Calculus II (integral calculus)
3. Calculus III (multivariate and vector calculus)
4. Differential Equations
5. Engineering Mathematics (systems of DEs, PDEs, numerical methods, vector calculus)

2 Courses, 3 Projects

3 projects designed to incrementally build student capability

1 project in Calculus III

2 projects in Engineering Mathematics

Calculus III

Lagrange Multipliers, optimize construction

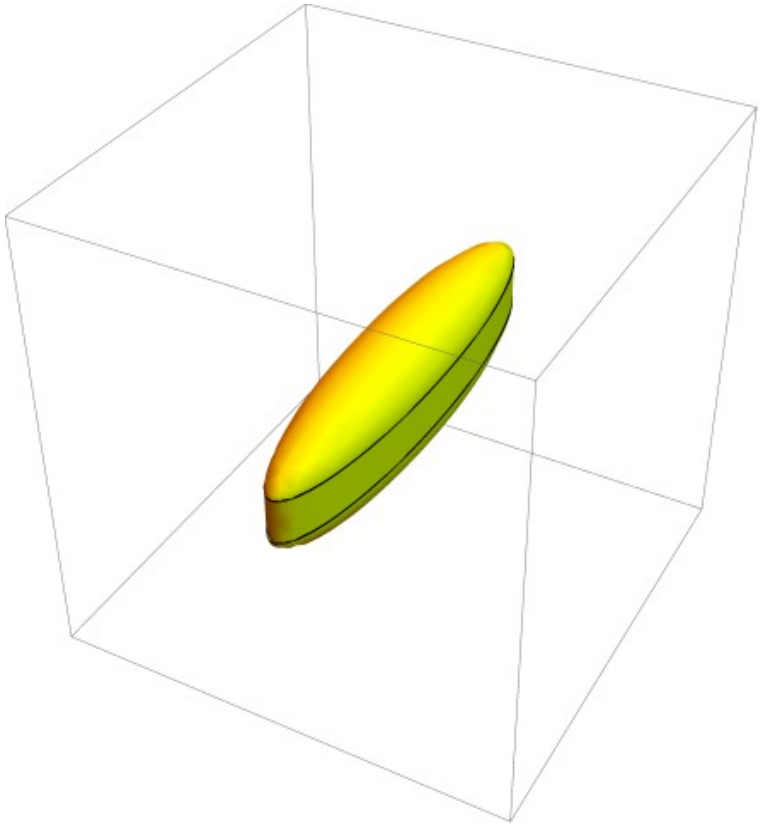
Students walked through process

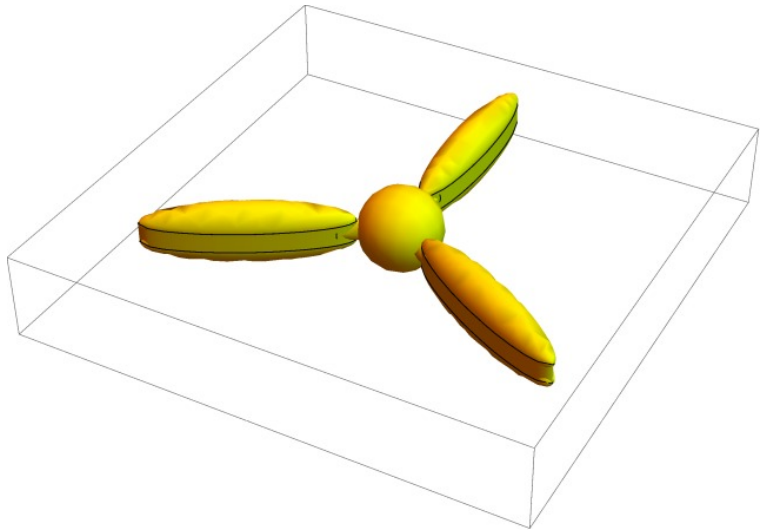
1. Optimize simpler version
2. Optimize complex version

Deliverables

1. Points paper justifying modeling
2. Points paper summarizing results and commented Mathematica code

Calculus III





Systems of ODEs

Compare analytic/numerical solutions to nonhomogeneous linear systems

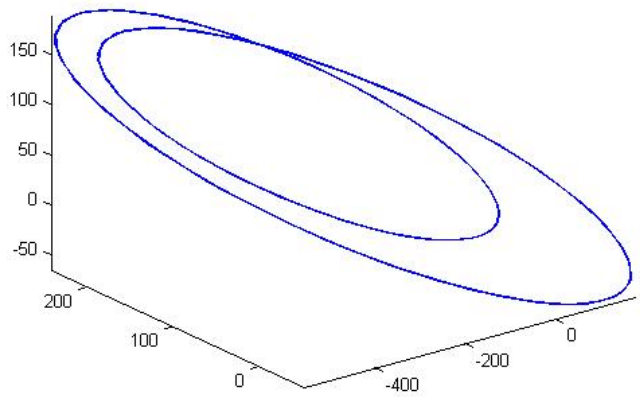
Jacobian analysis/numerical solution to nonlinear system

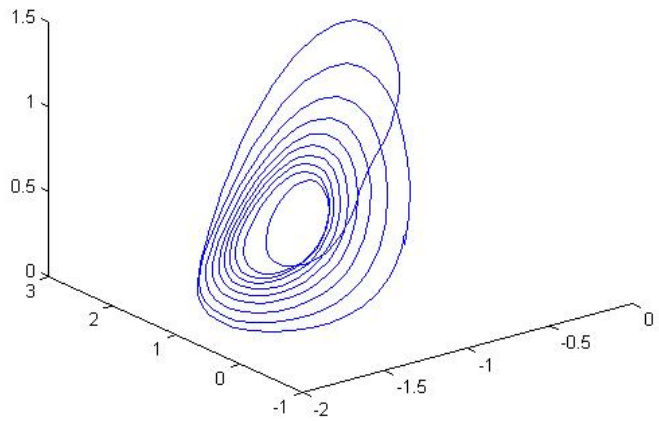
Less step by step instructions, close to class exercises

Deliverables

1. Draft technical report for peer review
2. Peer review
3. Final technical report with commented Mathematica and Matlab code

Systems of ODEs





PDEs

Analytic/numerical solution to 2D heat equation

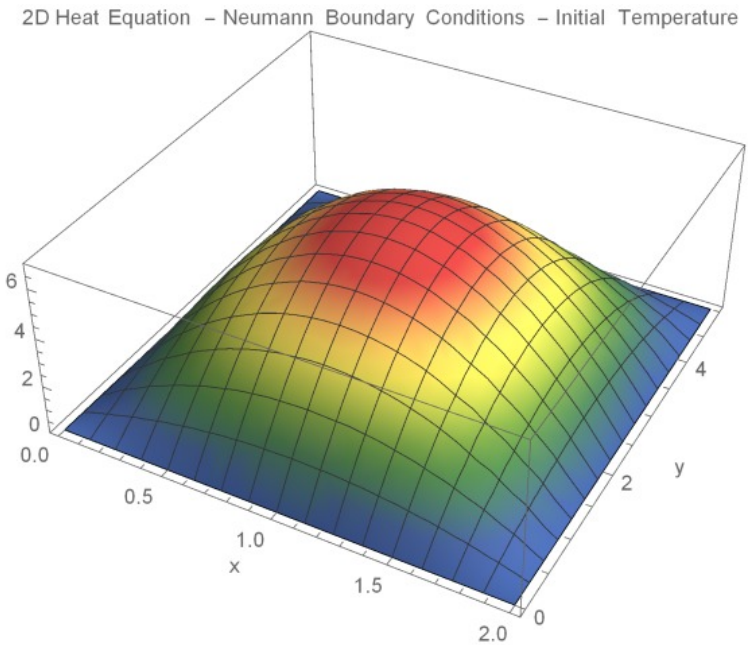
Mapping solution to a torus

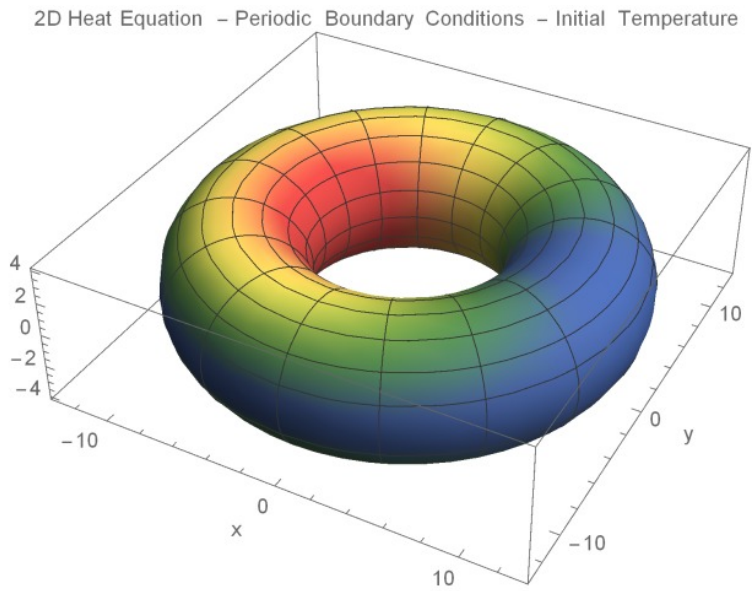
Extension from class exercises (1D heat and 2D Laplace)

Deliverables

1. Draft technical report for peer review
2. Peer review
3. Final technical report with commented Mathematica and Matlab code

Systems of ODEs





Lessons Learned

Calculus III Project

1. Starting with simpler model helps
2. Check values let students validate modeling

System of ODEs Project

1. Juniors/Sophomores still need very clear instructions
2. Peer review needs guidelines
3. Too much repetition in tasks detrimental

PDEs Project

1. Commenting code a common issue
2. Varying levels of success following extensions on in class exercises

Designing Projects for Engineering Mathematics Students

Jeremy L Thompson

United States Air Force Academy

jeremy.thompson@usafa.edu

April 9, 2015