Numerical Algebraic Geometry
MA 798: Topics in Numerical Analysis, Spring 2014

Class website: http://www.math.ncsu.edu/~jdhauens/ma798
11:20 am – 12:10 pm MWF
Daniels 232

Instructor: Dr. Jonathan Hauenstein

Office Hours: SAS 3152
Monday: 1 – 2 pm, Friday: 1 – 2 pm
Other times by appointment or drop-in

Phone: (919) 513 – 7443
Fax: (919) 513 – 7336
Email: hauenstein@ncsu.edu

Book: *Numerically Solving Polynomial Systems with Bertini.* Bates, Hauenstein, Sommese, and Wampler, 2013.

Additional Reading: *The Numerical Solution of Systems of Polynomials Arising in Engineering and Science.* Sommese and Wampler, 2005.
Ideals, Varieties, and Algorithms. Cox, Little, and O'Shea, 2010.
Using Algebraic Geometry. Cox, Little, and O'Shea, 2005.

Prerequisites: Numerical analysis (e.g., MA 427/428/580) and Algebra (e.g., MA 403/407/521/526), or permission from the instructor.

Description: Nonlinear systems of equations arise in many areas of science and engineering along with a wide variety of numerical solving techniques. When the equations are polynomial, algebraic geometry can be combined with numerical methods based on homotopy continuation to develop rigorous numerical solving algorithms. This course will introduce students to such algorithms, collectively called *numerical algebraic geometry*, from a computational viewpoint. At the end of the semester, students will give a presentation regarding polynomial systems arising in their research area.

Topics: This course will highlight some key computations including:

- Homotopy construction
- Isolated solutions
- Multiplicity and local dimension
- Postive-dimensional solution sets
- Numerical irreducible decomposition
- Real solutions
- Numerical elimination theory
- Invariants

Attendance: Each student is expected to attend every class lecture.

Electronics: Please respect your fellow students and prevent your electronic equipment from disrupting class.

Reading: The class website will contain information regarding topics covered in upcoming lectures and the corresponding sections in the book.

Guest lecturers: During the semester, there will be guest lecturers discussing related topics.

Presentation: At the end of the course, each student will give a 20 minute presentation on polynomial systems arising in their research area.

Grading: The grade will be based on attendance and participation (20%) and a presentation (80%).

Incompletes: Incompletes will be considered following University & Graduate School policy.

Absences and makeup work: Students are expected to arrive on time, stay the entire class, and contribute to the class discussion and group work. Excused absences and makeup exams will be handled according to University policy. Please notify the instructor in writing (email message is acceptable) prior to the date of absence when this is feasible. In cases where advance notification is not feasible (e.g., accident or emergency), the student should notify the instructor as soon as possible.

Disabilities: Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, the student must register with the Diasability Services Office (http://www.ncsu.edu/dso, 919-515-7653). For more information on University policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at http://policies.ncsu.edu/regulation/reg-02-20-01.

Copyright: All materials disseminated in class or on the web are protected by copyright laws. Copies or downloads are allowed for personal use. Distribution or sale of any of these materials in any form is strictly prohibited.

Academic Integrity: Students are required to comply with the University policy on academic integrity found in the Code of Student Conduct. When turning in your homework or exams, you are acknowledging the following statement: "I have neither given nor received unauthorized aid on this test or assignment."

Evaluation: Online class evaluations will be available for students to complete during the last 2 weeks of class. Students will receive an email message directing them to a website where they can login using their Unity ID and complete the evaluations. All evaluations are confidential: instructors will not know how any one student responded and students will not know the ratings of any particular instructor.