Engineering Analysis (ME 302) Fall 2015

Instructor: Dr. Xin (Frank) Yong, email: xyong@binghamton.edu

Office Location: Engineering & Science Building, Room 1320

Office Hours: Tuesday 3:00 pm-6:00 pm, and by appointment

Lecture Session Time: Tuesday, Thursday 1:15 pm-2:40 pm

Location: Engineering Building 110

Out-of-class Learning Time: Students are expected to devote 6 hours per week to this course, including time required for readings and assignments.

Teaching Assistants: Shiyi Qin, sqin5@binghamton.edu; Xiaoze Sun, xsun24@binghamton.edu

TA Office Hours and Location: Shiyi Qin: Friday 10:00 am-12:00 pm, ES 1304; Xiaoze Sun: Wednesday 3:00 pm-5:00 pm, ES 1304.

Course Description: The course covers important mathematical methods employed in solving various engineering and scientific problems. Topics include a review of ordinary differential equations and vector calculus; selected topics in linear algebra, Sturm-Liouville theory, Fourier series, and partial differential equations. The emphasis of the course is very much on solution techniques, rather than theorems and proofs. Examples, assignments and case studies introduced in the course are closely related to typical engineering applications.

Course Prerequisites:

- Calculus I-III MATH 221, 222, 323 or equivalent;
- Ordinary Differential Equations MATH 371 or equivalent.

Course Objectives:

- Introduce analytical methods to solve engineering problems.

 Desired Course Outcomes: Upon completion of this course, students should be able to:

- Apply matrix algebra to solve systems of linear equations;
- Formulate and solve eigenvalue-eigenvector problems for relevant engineering applications;
- Expand a function in a Taylor series/approximate a function by a Taylor polynomial;
- Develop analytic solutions for linear, constant-coefficient ODEs of first- and second-order;
- Solve linear, non-constant coefficient ODEs using series solutions;
- Compute the eigenvalue-eigenfunctions of Sturm-Liouville differential equations and perform eigenfunction expansions of suitably behaved functions;
- Expand suitably behaved functions in appropriate Fourier series;
- Use basic results from vector calculus in engineering analysis;
- Solve linear PDEs using the method of separation of variables;
- Use MATLAB to compute exact or approximate solutions of discussed problems;
Present the results using the graphical capabilities of MATLAB.

Textbook and Other Required Material:

- Required (recommended) textbook:
  

  Textbook #1 will be the textbook used in class. It focuses on introducing partial differential equations with a lot of engineering applications.

- References:
  

  Reference #1 is a very comprehensive text covering essential mathematic topics for engineering problems. It is also a good reference that you may want to keep during your study and beyond. Reference #2 is an alternative AEM text based on MATLAB that can serve as an additional reference and complementary reading. It is also recommended that you refer to an introductory text on MATLAB or the Mathworks website (mathworks.com) if you are not familiar with it.

Course Format: Class sessions will be used to develop topics, discuss applications and solve example problems. The Blackboard (Bb) course management system will be used to post notices and class materials. Students are expected to constantly check the Announcements Section and Content Section for any updates.

Tentative Course Topics

<table>
<thead>
<tr>
<th>Linear Algebra</th>
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<tbody>
<tr>
<td>Matrix, Determinants</td>
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<td>Cramer’s Rule</td>
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<td>Eigenvalues and Eigenvectors</td>
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<td>Case Study: Markov Process</td>
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<tr>
<th>Ordinary Differential Equations</th>
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<tr>
<td>ODEs, Review of Taylor’s Series</td>
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<td>Series Solutions</td>
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<td><strong>Singular Points and the Method of Frobenius</strong></td>
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<td><strong>Bessel’s Equation, Legendre’s Equation (Optional)</strong></td>
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### Exam 1

**Sturm-Liouville Theory**

- Boundary Value Problems
- The Sturm-Liouville Problem
- Eigenvalues and Eigenfunctions
- Eigenfunction Expansions
- Case Study: Vibrating Beam

### Fourier Series

- Periodic Functions, Even/Odd Functions
- Fourier Series of Arbitrary Periods
- Half-Range Expansions
- Case Study: Forced Oscillation and Resonance

### Exam 2

**Review of Vector Calculus**

- Differential Vector Calculus
- Integral Vector Calculus

### Partial Differential Equations

- Derivation of Wave Equation, Diffusion Equation, Laplace’s Equation
- Separation of Variables
- Solution of Field Equations on Rectangular Domains
- Case Study: Heat Transfer in a Rectangular Bar, Stokes’s First Problem, Elastic Waves in a Solid
Exam 3

**Homework policy:** Homework is probably the best way to learn the material and prepare for exams. Homework will be assigned on a regular basis and collected at the start of the lecture session one week later. From any given assignment, certain problems will be selected for grading. Late homework will still be accepted on the day that the homework is due, but there will be a 50% penalty on the grade. The MATLAB computing environment is required for the homework and case studies.

**Course Grading:** Homework (10%), Exam 1 (30%), Exam 2 (30%), Exam 3 (30%).

- The lowest homework grade will be dropped in calculating the overall course grade.
- There will be three in-class exams, the first two of which will be scheduled in the evenings so that you have adequate time to complete the exam. The third (NOT a cumulative final) exam will be given during the scheduled final exam period.
- The letter grade numerical equivalents will be as follows:

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>A</th>
<th>A-</th>
<th>B+</th>
<th>B</th>
<th>B-</th>
<th>C+</th>
<th>C</th>
<th>C-</th>
<th>D</th>
<th>F</th>
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<tbody>
<tr>
<td>Numerical Grade</td>
<td>95.0-100</td>
<td>90.0-94.9</td>
<td>87.0-89.9</td>
<td>83.0-86.9</td>
<td>80.0-82.9</td>
<td>77.0-79.9</td>
<td>73.0-76.9</td>
<td>70.0-72.9</td>
<td>60.0-69.9</td>
<td>&lt; 60.0</td>
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- There will be no incompletes granted in this course.

All students are expected to abide by the Honor Code for Binghamton University and the Watson School. See link below:

[http://www.binghamton.edu/watson/about/honesty-policy.pdf](http://www.binghamton.edu/watson/about/honesty-policy.pdf)