# CIE 516 – Advanced Mathematics for Civil Engineers

## 1   Course Information

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| **Prerequisites** | calculus and undergraduate engineering mathematics |
| **Classroom** | Fronczak Hall 454 (17-05-39) |
| **Class Hour** | Mon/Wed  10:00am - 11:20am |
| **Instructor** | Jongmin Shim (jshim@buffalo.edu) |
| **Office Hour** | Mon/Wed  11:20am - 12:30pm (Ketter Hall 240) |
| **Grader** | Fangjiao Ma (fangjiao@buffalo.edu) |
| **Office Hour** | Tue/Thur  12:30pm-1:30pm  (Ketter Hall 202) |

## 2   Recommended Learning Resources

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|---|---|
| **Textbook** | Advanced Engineering Mathematics (10$^\text{th}$ Ed.) by Kreyszig [concise] |
| **Course Web Page** | UBlearns |
| **References** | Fundamentals of Advanced Engineering Mathematics (2$^\text{nd}$ Ed.) by Greenberg [detailed] |
| | Introduction to Applied Mathematics (1$^\text{st}$ Ed.) by Strang [atypical] |
| | Linear Algebra and Its Applications (4$^\text{th}$ Ed.) by Lay |
| | http://mathworld.wolfram.com/ |

## 3   Course Objective and Description

The course objective is to provide students with a solid foundation in engineering mathematics. The course reviews the *undergraduate* engineering mathematics, and covers a range of topics that are relevant to contemporary civil engineers in research. Topics include linear algebra, ordinary differential equations, and integral transforms. It will emphasize fundamental concepts and analytical solution techniques.

- **Linear Algebra**  linear transformation, system of linear equations & matrix eigenvalue problem

- **Ordinary Differential Equation**  ODE overview & power series solution

- **Integral Transform** Laplace transform & Fourier analysis

## 4   Course Requirement

- **Class Structure** This is a lecture only course without any recitation classes; the class meets for 80 minutes, twice a week, for 15 weeks. There will be 3 quizzes and 1 final.

- **Office Hours and UBLearns Discussion Board** The instructor and the TA (or grader) will be available at least two times a week, respectively. If students have subject-related questions, they should post them in the *UBLearns Discussion Board*. For each topic, the instructor will create a forum, where students can share their questions by creating threads and either the instructor or the TA (or grader) answer them. *It is students' responsibility to frequently check the Discussion Board.* Direct emails to the instructor are preferred *only if they contain privacy.*

- **Class Attendance** While attendance is not mandatory, students should recognize that class attendance is required to do well in the course and is necessary to understand key points of the subject. All of the subjects covered in lectures is not necessarily available in the text.

- **Readings** All required readings will be covered in the problem sets and exams.

- **Problem Sets** Eight problem sets will be assigned during the semester, with a view that the students can apply the key concepts covered in the class lectures. Problem sets and their solutions will be uploaded in the UBLearns, but they will *not* be graded.

- **Quizzes** Three quizzes will be given on the subjects covered in the lectures and the problem sets. One or two problems will be given for each quiz ($\sim 30\ min$). If you have concerns regarding the graded quizzes, you should talk to the TA (or grader) within a week. *Before approaching the instructor, you should first consult the TA (or grader) and check the solutions. The lowest quiz score will be dropped.*

- **Final Exam**: One 3 $hr$ comprehensive final exam will be given. Students cannot miss the exam without the *prior* approval of the instructor for an acceptable excuse. Student, who misses the exam, will be assigned a zero score. Typically, the exam will be open-book including: textbooks, handouts, and class lecture notes. However, students are not allowed to circulate their books or notes in the exam. In addition, laptops or any other communicating devices, such as phones and tablets, are not allowed in the exam.

# 5  Grading Policy

Final course grade shall be determined based on the highest score out of the followings:

- **Type-A**

  ○ 50 points from two highest scores out of three quizzes (*i.e.*, 25 points per quiz)

  ○ 50 points from one final exam

  ○ ± 5 points for *professionalism*

- **Type-B**

  ○ 30 points from two highest scores out of three quizzes (*i.e.*, 15 points per quiz)

  ○ 70 points from one final exam

  ○ ± 5 points for *professionalism*

Make-up assignments will *not* be considered. Based on the highest score out of two, letter grades will be assigned. Exact cutoffs for specific grades will depend on the level of difficulty of quizzes and exams. These cutoffs will be determined once the final exam has been graded. However, the cutoffs will not exceed the following:

- **Tentative Grade Distribution**

  ○ $A^- \geq 90$

  ○ $B^- \geq 75$

  ○ $C^- \geq 60$

*I* Grade will be strictly limited to the circumstances for which the incomplete is intended; namely, satisfactory work to date and legitimate inability to complete the work within the semester. See UB policy (http://undergrad-catalog.buffalo.edu/policies/grading/explanation.shtml)

# 6    Classroom Professionalism

To provide an environment that is professional and conducive to learning, it is important that all students observe the following classroom etiquette (modified from http://undergrad-catalog.buffalo.edu/policies/course/obstruction.shtml).

- **In Class**
    - Come to class on time. If you must enter a class late, do so quietly and do not disrupt the class by walking between the class and the instructor. Do not leave class unless it is an absolute necessity.
    - Do not talk with other classmates while the instructor or another student is speaking.
    - Turn off the electronics: cell phones, laptops, and beeper watches.
    - Avoid audible and visible signs of restlessness. These are both rude and disruptive.
    - Focus on class material during class time. Sleeping, talking to others, doing work for another class, reading the newspaper, checking email, and exploring the internet are unacceptable and can be disruptive.
    - Do not pack bookbags or backpacks to leave until the instructor has dismissed class.

- **Outside the Classroom**
    - Students are expected to use professional style in all communications, including email, with course faculty and teaching assistants.
    - This includes the use of salutations and closings (including clear identification of the author) and correct grammar.

# 7    Academic Integrity

The University at Buffalo takes very seriously its commitment to principles of academic integrity. Please review the UB policies regarding academic integrity regularly (http://academicintegrity.buffalo.edu/).

As an engineer, you have special ethical obligations. As per the NSPE* Code of Ethics, "engineers shall avoid deceptive acts" and "shall conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession." For additional information about the procedures in place within the CSEE department, see the academic integrity section of the departmental website (http://www.csee.buffalo.edu/undergraduate/current-students/academic-integrity/).

# 8    Accessibility Resources

If you require classroom or testing accommodations due to a disability, please contact Accessibility Resources, located at 25 Capen Hall. Accessibility Resources can be reached by phone at (716) 645-2608 or by email at stu-accessibility@buffalo.edu. Please inform me as soon as possible about your needs so that we can coordinate your accommodations. For additional information see http://www.buffalo.edu/accessibility/index.php.

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*National Society of Professional Engineers

# 9  Course Schedule

Note that this schedule is tentative and is subject to change as the semester progresses.

| Lecture | Date | Topic | Kreyszig's | Remarks |
|---|---|---|---|---|
| | | **Linear Algebra : 5 weeks** | | |
| | | *Linear Transformation* | | |
| 1 | 08/28 | vector space, subspace, norm, inner-product | (7.9, 7.4) | |
| 2 | 08/30 | span, linear independence, dimension, basis | (7.9) | |
| | 09/04 | NO CLASS (*Labor Day*) | | |
| 3 | 09/06 | change of basis, coordinate transformation matrix | (-) | |
| 4 | 09/11 | linear transformation | (7.9) | PSet 1 |
| | | *System of Linear Equations* | | |
| 5 | 09/13 | systems of linear equations, Gauss elimination | (7.1-3) | |
| 6 | 09/18 | rank, existence/uniqueness of solution | (7.4-5) | Class+ $\boxed{Q1}$ |
| 7 | 09/20 | homogenous/non-homogeneous system, determinant, inverse | (7.6-8) | PSet 2 |
| | | *Matrix Eigenvalue Problem* | | |
| 8 | 09/25 | matrix eigenvalue problem | (8.1-2) | |
| 9 | 09/27 | special matrices, eigen-decomposition | (8.3-4) | |
| 10 | 10/02 | generalized matrix eigenvalue problem | (-) | PSet 3 |
| | | **Ordinary Differential Equation : 4.5 weeks** | | |
| | | *ODE Overview* | | |
| 11 | 10/09 | linear independence of functions | (2.6, 3.1) | |
| 12 | 10/04 | 1st-order ODEs | (1.1-5) | |
| | | *Homogeneous Linear ODEs* | | |
| 13 | 10/11 | reduction of order | (2.1) | Class+ $\boxed{Q2}$ |
| 14 | 10/16 | ODEs with constant coefficients | (2.2-5, 3.1-2) | |
| 15 | 10/18 | power series for analytic functions | (5.1) | |
| 16 | 10/23 | ODEs with variable coefficients: power series method | (5.2) | |
| 17 | 10/25 | ODEs with variable coefficients: Frobenius method | (5.3-5) | PSet 5 |
| | | *Non-homogeneous Linear ODEs* | | |
| 18 | 10/30 | undetermined coefficients | (2.7-9, 3.3) | |
| 19 | 11/01 | variation of parameters | (2.10) | PSet 4 |
| | | **Integral Transform : 4 weeks** | | |

| Lecture | Date | Topic | Kreyszig's | Remarks |
|---------|------|-------|------------|---------|
| | | *Laplace transform* | | |
| 20 | 11/06 | Special functions, Laplace transform | (6.1-6) | |
| (1) | 11/08 | *quiz only* | | $\boxed{Q3}$ |
| 21 | 11/13 | Properties of Laplace transform | (6.1) | |
| 22 | 11/15 | Application to ODEs | (6.2) | PSet 6 |
| | | | | |
| | | *Fourier Analysis* | | |
| 23 | 11/20 | Fourier series | (11.1-4) | |
| | 11/22 | NO CLASS (*Thanksgiving*) | | |
| 24 | 11/27 | Complex Fourier series | (11.9) | |
| 25 | 11/29 | Fourier integral, Fourier transform | (11.7-9) | |
| 26 | 12/04 | Sturm-Liouville problems | (11.5) | |
| 27 | 12/06 | generalized Fourier series | (11.6) | PSet 7 |
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| (2) | 12/15 | $\boxed{\textit{Final Exam}}$ NSC 210 / 8:00am-10:45am | [all topics] | |