CHE 445: Mathematical Methods in Chemical Engineering

Fall 2016

Course Syllabus

(after Prof. D. Ramkrishna, Purdue University)

Instructor and Office Hours

Prof. Meenesh R. Singh
Office: CEB 217
Office Hours: Mondays 3:45 - 4:45pm

Teaching Assistant and Office Hours

Mr. Chen Wang

Office Hours: Friday, Noon – 1 pm

Course Email Address

The email related to the course may be sent to mrsingh@uic.edu. If you would like a response, please include "CHE 445" in the subject line.

Lectures

MW 2:30 – 3:45 PM in CEB 218

Course Description

This course will focus on the techniques of mathematics, primarily linear, but with an introduction to nonlinear methodology that is grounded in linearization. Some introduction to numerical and approximate methods as well as perturbation techniques will also be covered. Applications to Chemical Engineering will be stressed throughout the course.

An attempt will be made to promote skills in *formulating* problems to the extent time will permit. Occasionally, homework will introduce you to associated topics *not necessarily* covered in the lectures.

No text is prescribed for the course. Rely on your class notes and on suggested collateral reading from the following books.

Collateral reading is recommended from the following books:

- **Amundson, N. R.**, *Mathematical Methods in Chemical Engineering. Matrices and their Applications*, Prentice-Hall, Englewood Cliffs, New Jersey, 1966. **(NRA)**
- **Varma, A. and M. Morbidelli,** *Mathematical Methods in Chemical Engineering*, Oxford University**.** Press, New York, 1996**. (VM)**

Other books may be suggested for specific topics as and when needed.

The topics are distributed in the semester as below:

1. *Week of August 22*- Review of determinants and matrices. Theory of algebraic equations. Applications to dimensional analysis, stoichiometry and thermodynamics.

2. *Week of August 29*- Eigenvalues and eigenvectors of matrices. Sylvester's expansion and its confluent form. Solution of a linear system of differential equations. Applications to stagewise operations.

3. *Week of September 5*- (5- Labor Day holiday) Kinetics of first order systems.

4. *Week of September 12*- Ordinary differential equations of higher order. Regular singular points and series solutions. Hypergeometric differential equations and associated functions.

5. *Week of September 19*- Sturm-Liouville systems. Green's function (pp 241-245). The method of separation of variables and applications to chemical engineering problems.

6. *Week of September 26*- Application of the method of separation of variables (contd.). Heat and mass transfer and chemical reactor problems.

 I Mid-Semester Exam. Monday, October 3, 2016. (Evening Exam to be announced)

7. *Week of October 3*- Elements of complex variables. Theory of analytic functions. The residue theorem. Laplace transforms (pp 553-555,559,562-565).

8. *Week of October 10-* Application of Laplace transform techniques to boundary value problems in heat and mass transfer (pp 589-599).

9. *Week of October 17-* Further applications of Laplace transforms. Solution of population balance equations with convolution integrals.

10. *Week of October 24-* The infinite Fourier transform and its applications to the solution of boundary value problems in infinite media (pp 486-502).

11. *Week of October 31-* Introduction to numerical and approximate solution of nonlinear systems. Algebraic and differential equations.

12. *Week of November 7-* First order quasilinear partial differential equations and the method of characteristics (pp 361-372). Formation of shock waves (pp. 419-443) and applications to chromatographic columns (pp 467-474)

13. *Week of November 14-* No class on Monday and Wednesday of this week as I will be away in San Francisco for the AIChE meeting. No make-up is needed in lieu of the two exams.

II Mid-Semester Exam. Monday, Nov. 14, 2016.

14. *Week of November 21-* (24 – 25 Thanksgiving Holidays) Systems of first order partial differential equations and multiple characteristics (pp 372-373). Regular (pp 616-619) and singular perturbation (pp 619-625) methods for differential equations.

Thanksgiving Vacation: Nov. 24-25, 2016

15. *Week of November 28-* Analysis of nonlinear dynamical systems (pp 91-97, 99-103)). Liapunov stability (pp 151-153). Elements of bifurcation theory (pp 163-166). Hopf bifurcation and applications in chemical engineering (pp 166-182).

16. *Week of December 5-* **Final Exams**

Homework:

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Homework will be handed out each week on Wednesday and their solutions are due back in the subsequent Wednesday. All solutions must be independent.

Course Grade:

The course grade will be based on evaluations of homework, two one-hour examinations and a final examination.

The weightage for homework is 30%, 20% for the first mid-semester exam, 20% for the second mid-semester exam, and 30% for the final exam.

Ethics and Academic Dishonesty:

Students in CHE 445 are continuing on a program of study to become chemical engineers. Engineers are expected to uphold a strict code of ethics in which they: (1) build their professional reputations on the merits of their services and (2) act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession. In addition to these broad ethical guidelines, students in CHE 445 will be expected to be honest and refrain from cheating on exams, and homework assignments (you should not turn in a homework that you did not work yourself).

Students caught cheating will be PROSECUTED TO THE MAXIMUM EXTENT possible under UIC guidelines.

Personally, I take all accusations of academic dishonesty very seriously, and I am asking each you to report any incidents or suspected incidents of cheating to me directly. I will keep your identity confidential.

Assignments: Any assignment you turn in is to be a product of your own efforts and your own understanding. If you do not understand what you are writing – DON'T WRITE IT. Anyone who copies the solution from another student or a solution manual is guilty of academic dishonesty. Anyone suspected of copying may be given an announced quiz to determine if their work was their own. Even if you "worked with someone", you must do it yourself.