NORTH CAROLINA STATE UNIVERSITY
DEPARTMENT OF CHEMICAL & BIOMOLECULAR ENGINEERING

CHE 711-601 **CHEMICAL ENGINEERING PROCESS MODELING** **Fall 2024**

INSTRUCTOR: Professor Peter S. Fedkiw

OFFICE HOURS: TuTh 1500-1600 (via Zoom: https://ncsu.zoom.us/j/97217596780)

REQUIRED TEXT: *Applied Mathematics and Modeling for Chemical Engineers, 3rd edition*
R.G. Rice, D.D. Do, and J.E. Maneval

EXAMS: September 25-27, October 30 - November 1, and December 9-10

GRADING: Exams (75%) + Homework (25%) **or** Exams (33.33% each)

TA: Mr. Kushal Yadav, TuTh 1600 - 1730, Zoom
https://ncsu.zoom.us/j/4426673798

Week	**Topic**	**Reading**
1	Model building	Ch. 1
1,2	Review of ordinary differential equations	Chs. 3 & 5
3,4	Series solution to ordinary differential equations Bessel functions	Ch. 4
4,5	Laplace transforms	Ch. 11.1, 11.9-11, App. C. & Handouts
6	Sturm-Liouville Systems	Chs. 12.5 & 13.2
7,8,9,10	Solution to partial differential equations - Separation of variables - Laplace and Fourier transforms - Similarity transform variables	Chs. 12, 13.1-2 & Handouts
11,12	Introduction to Numerical Solutions of Initial Value and Boundary Value Problems	Chs. 9, 10 & Handouts
13,14	Perturbation Methods	Ch. 8 & Handouts
14	Introduction to Calculus of Variations	Handout

Reference material (additional resources on course website)

F.B. Hildebrand, *Advanced Calculus for Applications*, 2nd edition, Prentice Hall, NY.

J.J. Tuma and R. Walsh, *Engineering Mathematics Handbook*, 4th edition, McGraw-Hill, NY.

I.S. Gradshteyn and I.W. Ryzhik, *Table of Integrals, Series and Products*, 5th edition, Academic Press, NY.

M. Abramowitz and I.A. Stegun, *Handbook of Mathematical Functions*, 7th edition, Dover Publications, Inc., NY. [An updated and expanded edition, *NIST Digital Library of Mathematical Functions*, is available at https://dlmf.nist.gov/]

"Introduction to Differential Equations" Wolfram U, https://www.wolfram.com/wolfram-u//introduction-to-differential-equations

"The Wolfram Language: FAST INTRODUCTION FOR PROGRAMMERS", https://www.wolfram.com/language/fast-introduction-for-programmers/en/

"An Elementary Introduction to the Wolfram Language", https://www.wolfram.com/language/elementary-introduction/2nd-ed/index.html

Learning Objectives:

At the conclusion of the semester, the student is able to:

1. Perform shell balances as a means to derive pointwise-conservation equations for both lumped and distributed parameter models.

2. Formulate and interpret nondimensional parameters generated from models and utilize small and/or large values of the nondimensional parameters as an analysis tool.

3. Solve analytically ordinary differential equations (ODEs) generated from models, with a focus on linear systems.

4. Solve numerically linear and nonlinear initial- and boundary-value ODEs generated from models.

5. Solve analytically two-dimensional, linear partial differential equations generated by distributed-parameter models.

6. Solve model equations (ODEs, PDEs, transcendental equations …) that contain a small parameter using perturbation techniques.

7. Formulate and solve models using variational calculus.

Policies and Procedures

See course website.

Homework Assignments

See course website.

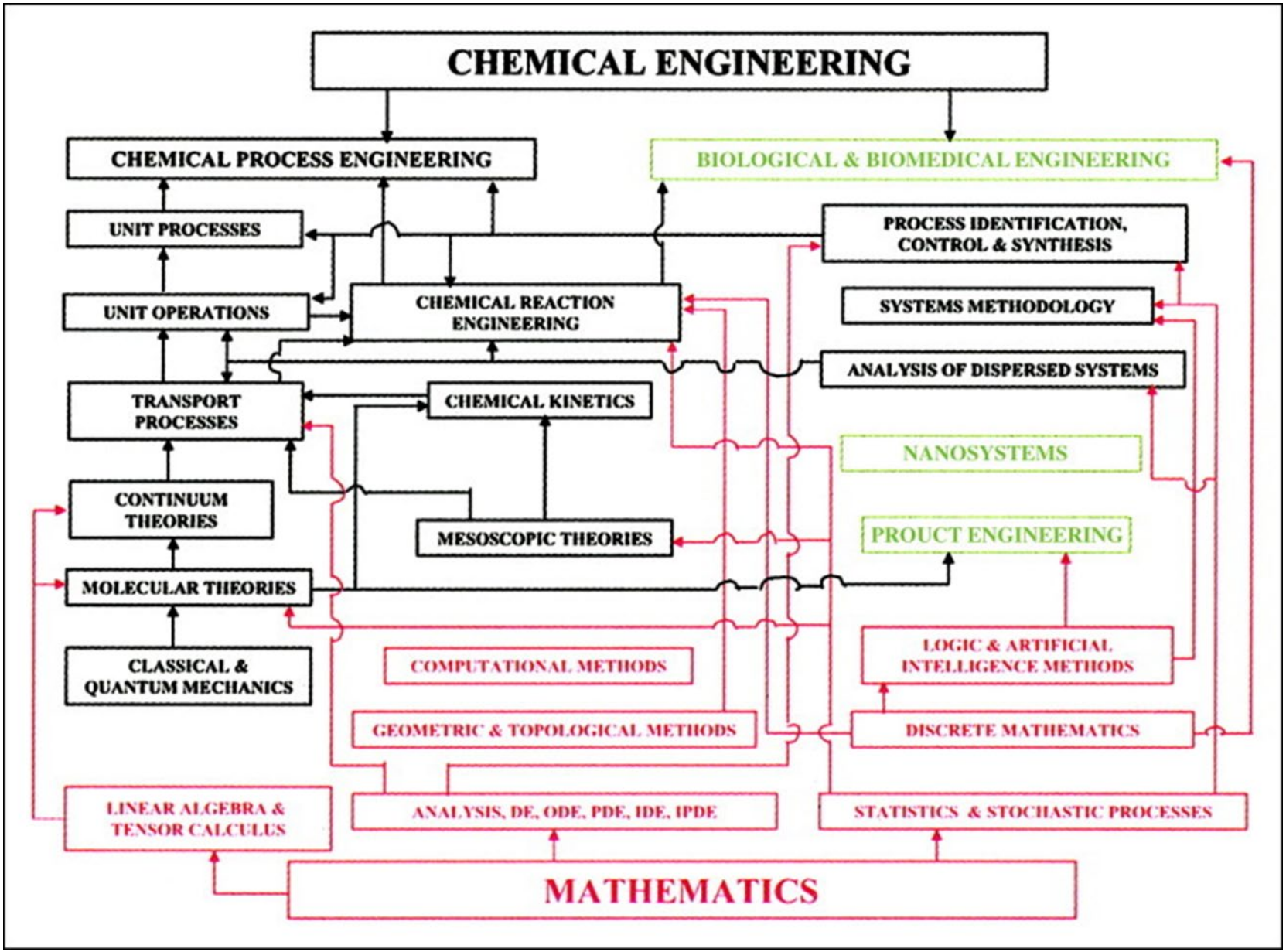

Figure 1. Chemical engineering and mathematics. The black color is used to represent traditional areas of chemical engineering and the green for the newer areas. Mathematics is shown in red and the arrows used to designate the areas of chemical engineering influenced by various domains of mathematics. (Ramkrishna and Amundson, AIChE J, 2004)