**Course**: ChE 531 – Mathematical Methods in Chemical Engineering

**Format**: 3 hr Lecture / 3 hr Credit

**Prerequisites**: Graduate Standing in Chemical Engineering or Permission

**Instructor**: Dr. Charter D. Stinespring, 421 Engineering Sciences building

293-9363; [charter.stinespring@mail.wvu.edu](mailto:charter.stinespring@mail.wvu.edu)

**Schedule**: TR 11:00 – 12:15 AM

**Location**: G84-Engineering Science Building

**Office Hours**: TBD and by appointment

**Course Goal**: The goal of this class is to develop mathematical and analytical skills enabling the student to formulate and solve deterministic problems encountered in the Engineering Sciences. Special emphasis will be given to problems in the area of Chemical Engineering.

**Learning Objectives**: Upon completion of this course, the student will be able to

1. Recognize and identify the type of differential equation in terms of the concepts of linearity, homogeneity, and order.
2. Solve a variety of 1st order differential equations using the methods covered in the course.
3. Solve linear second order ODEs by formulating the complementary function and particular integral solutions.
4. Formulate and solve non-linear ODE problems using the method of Frobenius to give a series solution.
5. Formulate and solve non-linear ODE problems leading to solutions involving Bessel functions.
6. Formulate and solve PDE problems that involve similarity solutions.
7. Formulate and solve PDE problems using the separation of variables method and the application of the Sturm-Lioville theorem.
8. Formulate and solve ODEs and PDEs using Laplace transforms and Fourier transforms.

**Textbook**: None, the student will develop a set of detailed course notes and will consult reference texts as needed

# Recommended Reference Texts

1. Applied Mathematics and Modeling for Chemical Engineers, R.G. Rice and D.D. Do, Wiley, New York (1995)
2. Advanced Engineering Mathematics, C.R. Wylie and L.C. Barrett, 5th Edition, McGraw-Hill, New York (1982)
3. Advanced Engineering Mathematics, E. Kreyszig, 6th Edition, Wiley, New York (1988)
4. Elementary Applied Partial Differential Equations, R. Haberman, 2nd Ed., Prentice-Hall Inc., Englewood Cliffs, NJ (1987)
5. Foundations of Applied Mathematics, M.D. Greenberg, Prentice-Hall Inc., Englewood Cliffs, NJ (1987)
6. Handbook of Mathematical Functions, Abromowitz and Stegun, Dover (1972)\*
7. Mathematical Handbook of Formulas and Tables, M.R. Spiegel, Schaum's Outline Series (1968)

**Student Evaluation**: Homework 30%, mid-term exam 35%, and final exam 35% (comprehensive). Collaboration is strongly discouraged on the homework. A standard grading scale will be used [100 – 90 = A, 89 – 80 = B, 79 – 70 = C, 69 – 60 = D, 59 – 0 = F]

**Exam/Grading Policy:** Exams will be closed book / closed notes. You will be allowed ***one page*** of notes (front and back). No make-up exams are allowed except by prior arrangement with instructor. Exam grading appeals must be made in writing on the day the exam is returned. Consistent with WVU guidelines, students absent from regularly scheduled examinations because of authorized University activities will have the opportunity to take them at an alternate time. University issued excuses are required for such absences. Make-up exams for absences due to *any other reason* will be at the discretion of the instructor. In the case of a medical emergency, a physician’s note is required for consideration of a makeup exam. If the fire alarm goes off during an exam, the resolution of the situation is at the discretion of the instructor.

**Attendance:** Class attendance is strongly recommended but records will not be kept. Those not in class for any reason are responsible for all material covered.

**Inclusivity Statement**: The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Office of Accessibility Services (293-6700). For more information on West Virginia University's Diversity, Equity, and Inclusion initiatives, please see <http://diversity.wvu.edu>.

**Academic Integrity**: The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Student Conduct Code at <https://tlcommons.wvu.edu/qualitymatters/syllabus-policies-and-statements>. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me before the assignment is due to discuss the matter.

**Civility in the Classroom:** In this course, you are expected to act in a manner consistent with the behavior expected in the professional workplace. Respect each other, come to class prepared, be supportive of others, be attentive, contribute when appropriate, and be engaged in your learning. Civility is expected and assumed. In order for everyone to have the opportunity to maximize learning, inappropriate or disruptive behavior is prohibited and may result in a request to leave the classroom at a minimum. Examples include, but are not limited to, using cell phones in class, texting in class, excessive tardiness or late arrivals, demanding special treatment, challenges to the instructor’s authority, leaving class early, shuffling backpacks and book bags, using offensive language or remarks, side discussions, playing games in class, sleeping, overt inattentiveness, and using a laptop during class unless instructed to do so.

**Recording of Lectures:** Recording of the lectures (photographic, video, and/or audio) in full or in part is not permitted. Students engaging in this activity will be asked to stop or leave the classroom.

**Approximate Course Schedule**: This schedule is subject to change.

**Week** **Topic**

1. Review of basic concepts - continuous and differentiable functions, limits, ordinary and singular points.
2. Introduction to ordinary differential equations (ODEs) – linearity, homogeneity, and order.
3. 1st order ODEs – integrating factor methods and special cases
4. Introduction to 2nd order ODEs and the concept of superposition
5. 2nd order ODEs – Linear, complementary functions and particular integrals
6. Series Solutions and the Method of Frobenius
7. Bessel Functions and Solutions to the Generalized Bessel Equation
8. Introduction to Partial Differential Equations
9. Similarity solutions and semi-infinite media solutions, introduction to the error function
10. Spring Break
11. Separation of Variables method, concepts of orthogonality and homogeneity, boundary conditions
12. Sturm-Lioville theorem
13. Laplace’s transforms
14. Fourier Series
15. Duhamel’s theorem and miscellaneous topics including Fast Fourier Transforms and Green’s Functions.
16. Final Exam