**College of Innovation and Solutions**                                            **Spring 2021**
**MATH 310 Differential Equations (3,0)**                                          **3 Credits**

**Prerequisites:** MATH 152 with a grade of C or better

**Instructor:** George Voutsadakis, CAS 206E, 906-635-2667, gvoutsad@lssu.edu

**COVID-19**:

LSSU Safety Protocols are based on federal, state, and local guidelines and recommendations from the Centers for Disease Control (CDC). The following four pillars provide the foundation for the continued safety and wellbeing of our University and surrounding community. Please do your part to adhere to these pillars.

1. **Social Distancing**: Maintain six feet of distance from those around you when possible.
2. **Mask/Face Covering**: Wear a mask or face covering when in enclosed, public locations and/or when other social distancing measures are difficult to maintain. * Per Michigan Executive order 2020-147 effective July 13, 2020, at 12:01 a.m., Lake Superior State University will require all individuals on campus property to wear a face covering when in any indoor space, and when outdoors and unable to consistently maintain a distance of six feet or more from individuals who are not members of their household. The requirement to wear a face covering does not apply to individuals who are giving a speech for broadcast or an audience. This means that a faculty member teaching a class does not have to wear their mask when they are speaking but will need to wear their mask when moving among students.
3. **Sanitization**: Wash your hands with soap and water for 20 seconds multiple times each day or use hand sanitizer of at least 60% alcohol. Sanitize your desk or workstation twice daily, high-frequency touch surfaces, and living spaces with wipes found across campus.
4. **Personal/Social Responsibility**: Actively encourage those around you to adhere to these pillars while doing so yourself. Remember, we are in this together and we all have a role to play in preventing the spread of COVID-19.

**Office Hours:**

| Tuesday | Wednesday | Thursday |
|---------|-----------|----------|
| 8:00-10:00 | 1:00-3:00 | 9:00-10:00 |

**Required Texts:** *Elementary Differential Equations,* William E. Boyce, Richard C. DiPrima, 10th Edition, John Wiley & Sons, 978-0-470-45832-7.

**Calculator:** The TI-83 Plus/ TI 84 is the recommended calculator for this course. On some of the exams and quizzes, the instructor may ask you to solve problems without using your calculators.

**Course Description:** This course covers first-order differential equations, second and higher order linear differential equations, the Laplace transform, systems of first order linear equations and applications of linear, ordinary differential equations in mathematics, science and engineering.

**Student Learning Outcomes:** At the conclusion of MATH 310, successful students will be able to:
1. *Differential Equations:* Describe the terminology related to differential equations and classify differential equations (partial/ordinary, linear/nonlinear, etc.).

2. *First-Order Differential Equations:* Classify first-order differential equations as linear, separable, homogeneous, autonomous and exact., solve initial-value problems involving first-order differential

equations, determine the existence and uniqueness of solutions, obtain mathematical models and their solutions for applications in mathematics, sciences and engineering using first-order differential equations.

3. *Second and Higher-Order Linear Differential Equations:* Solve homogeneous equations with constant coefficients, describe the linear independence of solutions and apply the principle of superposition, solve non-homogeneous equations using the method of undetermined coefficients and variation of parameters, obtain mathematical models and their solutions for applications in mathematics, sciences and engineering using second-order linear differential equations.

4. *Laplace Transforms:* Obtain the Laplace Transform and the inverse Laplace Transform of functions using the definition or a table of Laplace Transforms, solve initial-value problems using the Laplace Transform, describe the unit step and unit impulse functions, solve initial-value problems with discontinuous forcing functions, use the convolution integral in mathematical modeling.

5. *Systems of First-Order Differential Equations:* Obtain mathematical models for applications in mathematics, sciences and engineering using systems of first-order linear differential equations, generate the phase portrait for a system of equations, solve homogeneous and non-homogeneous systems of equations with constant coefficients using linear algebra methods.

**This course contributes to LSSU's Institutional Learning Outcomes by addressing:**

**2   Use of Evidence**:  Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem.
**3   Analysis and Synthesis**:  Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art.

**Grading Scale and Policies:**
*Point Values:*
Exams                                                                                          200 points
Final exam                                                                                     100 points
Quizzes                                                                                        100 points
                                                                                       Total 400 points

*Grading Scale%:*

**A** 90-100 (includes +/-) **B** 80-89 **C** 65-79 **D** 50-64 **F** 0-49

*Grading Policies:* You will be graded on correct methodology, i.e., if you provide an answer but show no work or your work is incorrect, you will receive no credit. Your solutions must be written in a connected, step-by-step logical fashion and all variables should be clearly defined. If your solution is not written clearly, you will not receive full credit. In many cases, setting up the correct mathematical model and using this model to solve a problem will be just as important as computing a numerical answer.

The homework exercises for each section covered are on the last page of this handout. You should spend a lot of your math study time doing homework. If you are struggling with your homework seek help from your instructor or the tutors in the Learning Center.

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The course outline on the next-to-last page is a projection of the general structure and content of the course. It is tentative and subject to change without prior notice.

### *Ground Rules*:
**1. Calculator:** The TI-83/84 Plus is the recommended calculator for this course. Your instructor reserves the right to ask you to solve problems in class, during quizzes and during exams without the use of a calculator. <u>All other electronic devices (computers, PDAs, cell phones etc.), must be turned off for all class lecture sessions.</u>
**2. Purpose of Lecture:** Lectures are an opportunity for students to ask questions and seek clarification on material. This implies student preparation has been accomplished prior to class. Lecture is also the opportunity for the instructor to coordinate coverage of the material and present material that is historically or potentially difficult. It does not negate student preparation or study.
**3. Attendance Policy:** Attendance is strongly encouraged. If you miss a class, or are late, you are still responsible for class notes and assignments. Moreover, **you will be assigned a 0 score should a quiz take place during that missed lecture**.
**4. Make-up Policy:** Each exam should be taken at the designated time. An exam may be taken prior to or after the scheduled date, by agreement with the instructor, provided that the student provides a request with a **documented valid excuse well in advance of the scheduled date**. **If an absence is unexcused, no make-up will be provided, either for exams or for quizzes**.
5. **Academic Integrity:** Students are expected to perform all assigned work themselves. Any form of cheating or plagiarism will be handled in accordance with the Academic Integrity Procedures. Violations of the University Academic Integrity Policy may result in an F course grade.
6. **Testing:** <u>Use of head phones, cell phones and hats during exams is prohibited.</u>

### *University Policies and Statements:*

**The Americans with Disabilities Act & Accommodations**
In compliance with Lake Superior State University policies and equal access laws, disability-related accommodations or services are available to students with documented disabilities. If you are a student with a disability and you think you may require accommodations you must register with Accessibility Services, which is located in the KJS Library, Room 233 (906) 635-2355 or x2355 on campus. Accessibility Services will provide you with a letter of confirmation of your verified disability and authorize recommended accommodations. This authorization must be presented to your instructor before any accommodations can be made. Students who desire such services should meet with instructors in a timely manner, preferably during the first week of class, to discuss individual disability related needs. Any student who feels that an accommodation is needed – based on the impact of a disability – should meet with instructors privately to discuss specific needs. The university will make reasonable accommodations for persons with documented disabilities. Students should notify the Coordinator of Accessibility Services (located in LBR 233), and their instructors, of any accommodation needs as soon as possible.

**IPASS (Individual Plan for Academic Student Success)**
If at mid-term your grades reflect that you are at risk for failing some or all of your classes, you will be contacted by a representative of IPASS. The IPASS program is designed to help you gain control over your learning through pro-active communication and goal-setting, the development of intentional learning skills and study habits, and personal accountability. You may contact 635-2887 or email ipass@lssu.edu if you would like to sign up early in the semester or if you have any questions or concerns.

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**Tentative Course Outline:**

| Week | Dates | Monday | Wednesday | Friday |
|------|-------|--------|-----------|--------|
| 1 | 01/18 | M. L. King | 1.1 | 1.2 |
| 2 | 01/25 | 1.3 | 2.1 | 2.2 |
| 3 | 02/01 | 2.3 | 2.3 | 2.6 |
| 4 | 02/08 | 3.1 | Review | Exam 1 |
| 5 | 02/15 | 3.2 | 3.3 | 3.3 |
| 6 | 02/22 | 3.4 | 3.5 | 3.5 |
| 7 | 03/01 | 3.6 | Review | Exam 2 |
| 8 | 03/08 | 4.1 | 4.2 | 4.3 |
| 9 | 03/15 | 6.1 | 6.2 | 6.3 |
| 10 | 03/22 | 6.4 | Review | Exam 3 |
| 11 | 03/29 | 6.5 | 6.6 | 6.6 |
| 12 | 04/05 | 7.1 | 7.2/7.3 | 7.4 |
| 13 | 04/12 | 7.5 | Review | Exam 4 |
| 14 | 04/19 | 7.6 | 7.8 | 7.9 |

**Suggested Homework Problems**

| Topic | Section | ASSIGNMENT |
|-------|---------|------------|
| Introduction; Direction Fields | 1.1 | p7: 15-20,  22 |
| Solutions of some DEs; Classification of DEs | 1.2,1.3 | p15: 1b, 7; p24: 1-4, 8, 11, 17, 20 |
| 1$^{st}$ order linear equations | 2.1 | p39: 14, 16, 18, 20 |
| Separable equations | 2.2 | p48: 1, 2, 7, 9, 15 |
| Modeling with 1$^{st}$ order equations | 2.3 | p60: 1, 3, 4, 16 |
| Modeling with 1$^{st}$ order equations | 2.3 | p60: 20, 21a, 22a |
| Exact Equations | 2.6 | p101: 1, 4, 7, 13, 16 |
| 2$^{nd}$ order homogeneous equations | 3.1 | p144: 1, 5, 6, 9, 15, 21 |
| Fundamental solutions; the Wronskian | 3.2 | p155: 1, 2, 23, 24, 25 |
| Complex roots of the characteristic equation | 3.3 | p164: 7, 11, 12, 17, 18 |
| Repeated roots | 3.4 | p172: 1, 2, 4, 12, 16 |
| Method of Undetermined Coefficients | 3.5 | p184: 1, 3, 4, 14, 19a, 20a, 21a |
| Variation of Parameters | 3.6 | p190: 1, 7, 15 |
| Higher order differential equations | 4.1 - 4.3 | p233: 11, 14, 18, 31; p239: 2, 11, 13, 14, 15 |
| Definition of the Laplace Transform | 6.1 | p315: 5, 6, 7, 12 |
| Inverse Laplace Transform | 6.2 | p324: 1, 4, 7, 8 |
| Solution of Initial Value Problems | 6.2 | p324: 11, 13, 14, 21, 24 |
| Step Functions | 6.3 | p333: 1, 2, 7, 8, 11, 14, 15 |
| Diff. Eq. w/ Discontinuous Forcing Function | 6.4 | p340: 1, 4, 6, 9 |
| Impulse Functions | 6.5 | p348: 2, 5, 14 |
| The Convolution Integral; Transfer Function | 6.6 | p355: 4, 5, 8, 11, 13, 14 |
| Systems of First Order Linear Equations | 7.1 | p363: 1, 3, 5, 18 |
| Review of Matrices; Eigenvalues, Eigenvectors | 7.2, 7.3 | p376: 1, 22, 23; p388: 15, 16, 17, 19 |
| Homogeneous Linear Systems | 7.4, 7.5 | p405: 1, 2, 15, 16 |
| Complex Eigenvalues | 7.6 | p417: 1, 2, 9, 10 |
| Repeated Eigenvalues | 7.8 | p436: 1, 3, 7, 8 |
| Nonhomogeneous Linear Systems | 7.9 | p447: 1, 5, 7 |