**Instructor:**     Dr. N. Tatar

Course:          **MATH 667:** Advanced Partial Differential Equations II

**Objectives**:        This course prepares students to be able to classify $1^{st}$ order PDEs. Using the Lagrange method and the characteristics method, they should be able to solve some hyperbolic systems of PDEs. They will be also capable of applying these methods to problems arising in wave theory and gas dynamics. Finally, they will be exposed to some existence and uniqueness results and single/double layers (in potential theory).

**Course Description:** Classification of first order systems. Hyperbolic systems, method of characteristics. Applications to gas dynamics. Dispersive waves; application to water waves. Potential theory, single and double layers, existence theory for Dirichlet and Neumann problems.

**Prerequisite:**     MATH568

**Credit:**          3 credit hours

**References:**
1- G. B. Whitham, Linear and Nonlinear Waves, John Wiley & Sons, Inc. New York, Chichester, Weinheim, Brisbane, Singapore, Toronto, 1999
2- H. K. Rhee, R. Aris and N. R. Amundson, First-order Partial Differential Equations Vol. I, Dover Publications, Inc. New York, 1986
3- Li Ta-tsien, Global Classical Solutions for Quasilinear Hyperbolic Systems, John Wiley & Sons, Inc. Chichester, New York, Brisbane, Toronto, Singapore, 1994
4- Handouts

| Week | | Topics | |
|---|---|---|---|
| 1 | | Preliminaries: Multivariable calculus, ODEs | |
| 2 | | Classification: $1^{st}$-order systems of PDEs | |
| 3-4 | | Traffic flow, Transport problems, Formation of PDEs | |
| 5 | | Cauchy problem and IVP, Solving PDEs | |
| 6 | | Lagrange Method | |
| 7-8 | | Characteristics Method for hyperbolic systems | |
| 9 | | Burgers equation, Traffic flow | |
| 10 | | Gas dynamics | |
| 11-12 | | Existence theory for Dirichlet and Neumann problems | |
| 13 | | Dispersive waves, water waves | |
| 14-15 | | Potential theory: single and double layers | |

**Grading:**    Midterm                          25%
             CW (HMW + Participation)    35%
             Final Exam                       40%

**Instructions:**.
   1. Students are required to strictly adhere to the university's attendance policy.
   2. DN-Grade will be assigned to eligible students after their instructors have issued two warnings.

3. Students are prohibited from carrying mobile phones, smartwatches, or any electronic devices into the exam hall. Any breach of this rule will be treated as an attempted act of cheating.

**Cheating in Exams:** Cheating or any attempt of cheating by use of illegal activities, techniques and forms of fraud will result in a grade of DN in the course along with reporting the incident to the higher university administration for further action. Cheating in exams includes (but is not restricted to):

➢ Looking at the papers of other students.
➢ Talking to other students.
➢ Using mobiles, smart watches or any other electronic devices.
➢ Using ChatGPT or any AI source.

**Missing an Exam:** In case a student misses an exam (Exam I, Exam II, Midterm or the Final Exam) for a legitimate reason (such as medical emergencies), he/she must bring an official excuse from Students Affairs. Otherwise, he/she will get a score of zero in the missed exam.

**Attendance:** Students are expected to attend all classes.

If a student misses a class, he/she is responsible for any announcement made in that class.

After warned **twice** by the instructor, a DN grade will be awarded to any student who accumulates

9 unexcused absences. (20%)

15 excused and unexcused absences. (33.3%)

**The Usage of Mobiles in Class:** Students are not allowed to use mobiles for any purpose during class time. Students who want to use electronic devices to take notes must take permission from their instructor. Violations of these rules will result in a penalty decided by the instructor.

**Academic Integrity:** All KFUPM policies regarding ethics apply to this course.