Fayetteville State University
College of Arts and Sciences
Department of Mathematics and Computer Science
MATH 671- Partial Differential Equations
Fall Semester – 2010

"In case FSU must close for an emergency during the semester, instruction will continue using Blackboard."

I. LOCATOR INFORMATION:

Instructor**:** Dr .Frank Nani
Course # and Name: **Math 671-01 PDE** Office Location: SBE 314
Semester Credit Hours: 3 credit hours
Office hours: MWF 5-6PM
Day and Time Class Meets: **M W 7:15-8:45pm**
Office Phone: 910 672 1793
Total Contact Hours for Class: 24 HRS Email address: fnani@uncfsu.edu

FSU Policy on Electronic Mail: Fayetteville State University provides to each student, free of charge, an electronic mail account (studentid@broncos.uncfsu.edu) that is easily accessible via the Internet. The university has established FSU email as the primary mode of correspondence between university officials and enrolled students. Inquiries and requests from students pertaining to academic records, grades, bills, financial aid, and other matters of a confidential nature must be submitted via FSU email. Inquiries or requests from personal email accounts are not assured a response. The university maintains open-use computer laboratories throughout the campus that can be used to access electronic mail. **Rules and regulations governing the use of FSU email may be found at** http://www.uncfsu.edu/PDFs/EmailPolicyFinal.pdf

II. COURSE DESCRIPTION:

Partial Differential Equations: A study of topics such as Cauchy-Kowalewsky theorem, existence and regularity of the solutions, Dirichlet problem for linear elliptic equations, Cauchy problems, hyperbolic equations, and fundamental solutions of linear equations with constant coefficients. *Prerequisites: MATH 331 and MATH 571.*

III. DISABLED STUDENT SERVICES:

In accordance with Section 504 of the 1973 Rehabilitation Act and the Americans with Disabilities Act (ACA) of 1990, if you have a disability or think you have a disability to please contact the Center for Personal Development in the Spaulding Building, Room 155 (1st Floor); Tel: 910-672-1203.

IV. TEXTBOOK:

Lecture notes will be provided by the instructor

Karl E. Gustafson, **Introduction to Partial Differential Equations and Hilbert Space Methods**, 3rd ed., Dover Publications, Inc., Mineola, New York 1999

Nagle, R. Kent, **Fundamentals of Differential Equations**, 4th ed., Addison-Wesley Publishing Company, Inc. New York, Mass. 1996.

Zauderer, Erich, **Partial Differential Equations of Applied Mathematics,** 2nd ed., A Wiley-Interscience Publication, John Wiley & Sons, Inc, New York, 1998

V. STUDENT LEARNING OUTCOMES:

Upon completion of this course, students will be able to:

- Classify Partial Differential Equations
- Understand the physics related to Partial Differential Equations.
- Solve quasi-linear Partial Differential Equations using method of characteristics.
- State the Max Principle
- State the Cauchy-Kowalersky Theorem
- Able to solve heat equation using Fourier Series and Fourier Transforms.
- Understand Dirichlet Poisson Formulas.
- Use numerical methods to solve Partial Differential Equations.
- Basic knowledge of Sobolev Space.
- Know the Lax-Milgram Lemma, Poincare Lemma
- Apply Partial Differential Equations to real life

Course Competencies:

DPI

1.0 Ability to recognize and solve Partial Differential Equations problems involving complex variables

1.1 Use PDE solution techniques to solve "real world" problems that arise in engineering, biological sciences, physical sciences, and other mathematical sciences.

10. PDE and PDE Structures

2.1 Understand the concepts Partial Differential Equations.

a. D'Alembert and Duhamel solutions to Wave equation

b. Understand the applications of Cauchy-Kowalevsky Theorem to initial value PDEs

c. Ability to use Fourier Series to solve Heat Equations

d. Have basics knowledge of second order PDE and their solution technique.
e. Understand the concept of Sobolev spaces, Mollifiers, Weak derivatives, Generalized derivatives, Sobolev embedding Theorems

11.2 Develop skills in using interactive and recursive techniques in solving problems.

11.5 Use computers and graphing calculators to explore mathematical concepts.

NCATE

10. MATHEMATICS PREPARATION

a. Programs prepare prospective teachers who—
i. Use a problem-solving approach to investigate and understand mathematical content.
ii. Formulate and solve problems from both mathematical and everyday situations.

b. Programs prepare prospective teachers who can communicate mathematical ideas.
i. In writing, using everyday and mathematical language, including symbols.

ii. Orally, using both everyday and mathematical language.

c. Programs prepare prospective teachers who can make and evaluate mathematical conjectures and arguments and validate their own mathematical thinking.

d. Programs prepare prospective teachers who—
i. Show an understanding of the interrelationships within mathematics.
ii. Connect mathematics to other disciplines and real-world situations.

e. Programs prepare prospective teachers who—
i. Understand and apply concepts of complex number theory and complex variables.
ii. Understand and apply concepts of real analysis and extend them to complex analysis.

f. Programs prepare prospective teachers who—
i. Use calculators in computational and problem-solving situations.
ii. Use computer software to explore and solve mathematical problems.

11. TEACHING PREPARATION

2.1 Programs prepare prospective teachers who can identify and model strategies used for problem solving in grades 7 – 12.

a. Programs prepare prospective teachers who use graphing calculators, computers and other technologies as tools for teaching mathematics.

VI. COURSE REQUIREMENTS AND EVALATION CRITERIA:

a. Grading Scale:

A	**92-100%**
B	**83-91%**
C	**73-82%**
D	**64-72%**
F	**Below 64%**

b. Attendance Requirements – Students are expected to **enter the classroom on time** and remain until the class ends. **Three late arrivals and/or early departures will constitute an absence**. The class attendance policy given in the 2009-2010 FSU Catalogue will be strictly adhered to. Students are allowed to miss no more than 10% of the classes/labs with acceptable excuses.

c. Graded Assignments/Values:

Tests	40%
Homework	10%
Class Commitment/Participation	05%
Final Exam	45%

d. Policy on Missed or Late Assignments: No late homework assignments will be accepted or makeup tests will be given without the course instructor's prior permission.

e. Other - **Dishonesty on graded assignments will not be tolerated!!!** Students must neither give nor receive any assistance on any work to be graded. The University's cheating policy will be applied for any violations. The minimum penalty will be a grade of zero (0) on the assignment.

COURSE REQUIREMENTS:

Conduct of Course/Classroom Decorum

1. It is the responsibility of the students to avail themselves of **all** class meetings, tutorial/lab sessions and individual help from their instructors. Additional services are provided by Student Services in the Helen T. Chick Building. There are computer software tutorials available for your use in the Helen T. Chick Building, 2nd floor (See Lab Assistants). Each student should have the textbook and graphing calculator during each class session.

2. Students are responsible for maintaining a notebook of problems selected by the instructor. Students are encouraged to include as many additional problems as possible.

3. A test will be given at the end of each chapter. The tests will be announced well in advance of their administration. These tests will be subjective and/or objective. Since the lowest chapter test will be dropped, **no make-up test** will be given. The final examination is cumulative; it covers the contents of all chapters.

4. Students must refrain from smoking, eating, chewing gum and drinking in the classroom. The rights of others must be respected at all times.

5. Students are encouraged to ask questions of the instructor in class and to respond to those posed by the instructor. They should not discourage others from raising or answering questions. Often, other students have the same questions, which they wish to ask, but are hesitant to do so.

6. Students are expected to complete all class assignments and to spend adequate time on their class work to insure that the course outcomes are met. At least two hours of home study are expected for each class hour.

7. Talking in class between students is strictly unacceptable. Discussions should be directed to the instructor.

9. **Students are not allowed to bring babies and children to class!**

FSU Policy on Disruptive Behavior in the Classroom

The *Code of the University of North Carolina* (of which FSU is a constituent institution) and the *FSU Code of Student Conduct* affirm that all students have the right to receive instruction without interference from other students who disrupt classes.

FSU Core Curriculum Learning Outcome under Ethics and Civic Engagement (6.03): All students will "prepare themselves for responsible citizenship by fulfilling roles and responsibilities associated with membership in various organizations." Each classroom is a mini-community. Students learn and demonstrate responsible citizenship by abiding by the rules of classroom behavior and respecting the rights all members of the class.

The FSU Policy on Disruptive Behavior (see FSU website for complete policy) identifies the following behaviors as disruptive:

1. Failure to respect the rights of other students to express their viewpoints by behaviors such as repeatedly interrupting others while they speak, using profanity and/or disrespectful names or labels for others, ridiculing others for their viewpoints, and other similar behaviors;
2. Excessive talking to other students while the faculty member or other students are presenting information or expressing their viewpoints.
3. Use of cell phones and other electronic devices;
4. Overt inattentiveness (sleeping, reading newspapers);
5. Eating in class (except as permitted by the faculty member);
6. Threats or statements that jeopardize the safety of the student and others;
7. Failure to follow reasonable requests of faculty members;
8. Entering class late or leaving class early on regular basis;
9. Others as specified by the instructor.

The instructor may take the following actions in response to disruptive behavior. Students should

VII. ACADEMIC SUPPORT RESOURCES

Use any academic support resources available in this class. In addition,

1. The Mathematics Laboratory (located at H.T. Chick 216 C) provides computer-assisted instruction and peer tutoring for students who wish to strengthen their mathematics skills. Students enrolled in MATH 123, College Algebra, may complete weekly assignments on MATHXL in the Mathematics Laboratory. Please visit http://www.uncfsu.edu/learningcenter/math/ for lab schedules. Information on how to access and use ***Smarthinking*** and ***Criterion*** can be obtained through University College Learning Center (H. T. Chick 216 C)**.**

VIII. COURSE OUTLINE:

SECTIONS	TOPICS	ASSIGNMENTS
Lecture 1.1	Introduction to the physics of PDEs : Derivation of the Heat Equation, and Wave Equation; Elementary solutions using Fourier Series	
Lecture 1 .2	Generalized PDEs, The Cauchy problem for PDEs; Cauchy-Kowalevsky Theorem. IBVPs	
Lecture 1. 3	Classification of PDEs : Elliptic, Parabolic , Hyperbolic	Assignment #1
Lecture 1. 4	Calculus of variations, the KdV equation	Assignment #2
Lecture 1.5	The Euler-Lagrange equation	Assignment #3
Lecture 1.6	REVIEW	
	Test # 1	
Lecture 2.1	First Order Quasilinear PDE	
Lecture 2.2	Solution techniques of first order quasilinear PDE; Method of characteristics, Monge cones; shocks	Assignment #4
Lecture 2.3	Higher order PDE: Elliptic, Parabolic, Hyperbolic	
Lecture 2.4	Integral Transform solution techniques Solutions to hyperbolic equations using Riemann invariants	Assignment #5
	Test # 2	
Lecture 3.1	Reaction –Diffusion equation, Fick's Law	
Lecture 3.2	Mathematical modeling using PDEs	
Lecture 3.3	Heat, Laplace and Poisson equations	
Lecture 3.4	Generalized functions, fundamental solutions	
Lecture 3.5	Riez representation theorem, Green's representation solution to Dirichlet problem, Poisson Integral, Strong and weak maximum principle, Energy Inequalities, Uniqueness of solutions	Assignment #6
	Test # 3	
Lecture 4.1	The Wave equation	
Lecture 4.2	1-D d"Alembert formula, Duhamel's principle	
Lecture 5.1	Conservation of energy, Garding inequality	
Lecture 5.2	Numerical Techniques for solving PDEs	
Lecture 5.3	Finite Element methods	
Lecture 5.4	Computer –based solutions MATHLAB, MATHEMATICA	Assignment #7
	REVIEW Test #4	
Lecture 6.0	Sobolev spaces	

Lecture 6.1	Basic theory of conformal mappings	
Lecture 6.2	Fractional Linear Transformation	
Lecture 6.3	Schwarz-Christoffel Transformation	
Lecture 6.4	Applications of Conformal Mappings to Laplace's Equation, Heat	
Lecture 6.5	Bilinear forms, Lax-Milgram lemma, Mollifiers, Weak derivatives , $W^{k,p}$ spaces,	
Test # 5		
Final Exam		

***Note**: The above tentative schedule may subject to change per instructor's notice.*

IV.TEACHING STRATERGIES:

The teaching strategy for the course will vary depending upon the learning styles and strengths of the students enrolled. It is expected that the instructor will place emphasis on lectures, discussions, review and analysis, graphing calculator usage, and cooperative learning.

X. BIBLIOGRAPHY:

Karl E. Gustafson, **Introduction to Partial Differential Equations and Hilbert Space Methods**, 3rd ed., Dover Publications, Inc., Mineola, New York 1999

Nagle, R. Kent, **Fundamentals of Differential Equations**, 4th ed., Addison-Wesley Publishing Company, Inc. New York, Mass. 1996.

Zauderer, Erich, **Partial Differential Equations of Applied Mathematics,** 2nd ed., A Wiley-Interscience Publication, John Wiley & Sons, Inc, New York, 1998

.