Syllabus
Equations of Mathematical Physics

1. GENERAL INFORMATION	
Faculty	Information Technology
Major code and title	5B070500 Mathematical and Computer Modeling
Year, semester	3rd year, 5th semester
Subject category	Compulsory
Number of Credits	3
Language of Delivery	English
Prerequisites	Differential Equations
Postrequisites	Mathematical Methods for Modeling of Physical Processes
Lecturer	Roza E. Uteshova, assistant professor, candidate of physical and mathematical sciences Room 808, e-mail: r.uteshova@iitu.kz Office hours: Monday, Wednessday 12.00-14.00
Instructors	Roza E. Uteshova

2. GOAL AND OBJECTIVES OF THE COURSE

The goal of the course is to help students to develop skills and knowledge of standard concepts in partial differential equations (PDEs).

The objectives of the course are to:

- Introduce students to partial differential equations
- Develop different methods for solving PDEs
- Introduce students to some physical problems in Engineering and Physical models that results in partial differential equations

Learning outcomes of the course

Students successfully completing the course will be able to:

- Explain concepts and theory of basic methods for solving PDEs
- Recognize the types of second-order PDEs as typified by classical equations of mathematical physics, such as the wave equation, heat-diffusion equation and Laplace equation
- Apply eigenfunction expansion method to solve of heat-diffusion and wave equations
- Apply Laplace transform to solve problems for PDEs
- Formulate mathematical models for a range of scientific and engineering problems involving partial differential equations

3. COURSE DESCRIPTION

This course introduces students to the theory of boundary value and initial value problems for partial differential equations with emphasis on linear equations. Topics covered include Laplace's equation, heat equation, wave equation, eigenfunctions expansion, separation of variables, Laplace transform, method of characteristics.

4. COURSE POLICY

Students are forbidden to:

- submit any tasks after the deadline. Late submissions are graded down.
- cheat. Plagiarized papers shall not be graded;
- be late for classes;
- retake any tests, unless there is a valid reason for missing them;
- use mobile phones in class.

Students should always

- be appropriately dressed (formal/semi- formal styles are acceptable);
- show consideration for and mutual support of teachers and other students;

- let the teacher know of any problems arising in connection with their studies.

5. Literature

Basic literature:

1. Stanley J. Farlow, *Partial Differential Equations for Physical Scientists and Engineers*, Dover Publications, Inc., New York, 1993.
2. Matthew P. Coleman, *An Introduction to Partial Differential Equations with MATLAB*, CRC Press, 2013.

Supplementary literature:

1. Erwin Kreiszig, *Advanced Engineering Mathematics*, 10th ed., John Wiley & Sons, Inc., 2011.
2. N.Piskunov, *Differential and Integral Calculus*, Mir Publishers.

6. Course Content

6.1 Lecture, practical/seminar/laboratory session plans

Abbreviation	Meaning
TSIS	Teacher supervised independent work (CPCII)
SIS	Students' independent work (CPC)
IHW	Individual homework
PA	Practical assignment

Week No	Course Topic	Reference Materials	Lectures (1 h/w)	Practical classe (1 h/w)	TSIS (1 h/w)	SIS (3 h/w)
1	Basic concepts of equations of mathematical physics. Classification of partial differential equations and canonical forms.	Basic [1]-[3]	L 1	PA 1	TSIS 1	SIS 1
2	Fourier series. Elements of the Sturm-Liouville theory. Eigenvalue problems.	Basic [1]-[3]	L 2	PA 2	TSIS 2	SIS 2
3	Modeling: vibrating string. Wave equation.	Basic [1]-[3]	L 3	PA 3	Quiz 1	
4	Solution by separating variables. Use of Fourier series.	Basic [1]-[3]	L 4	PA 4	TSIS 3	SIS 3
5	D'Alembert solutions of the wave equation. Characteristics.	Basic [1]-[3]	L 5	PA 5	TSIS 4	SIS 4
6	Modeling: heat flow from a body in space. Heat equation.	Basic [1]-[3]	L 6	PA 6	Quiz 2	
7	Heat equation: solution by Fourier series. Steady two-dimensional heat problems. Dirichlet problem.	Basic [1]-[3]	L 7	PA 7	TSIS 5	SIS 5
8	The infinite and semi-infinite heat equations	Basic [1]-[3]	L 8	PA 8	Mid-term	
9	Modeling: membrane, two-dimensional wave equation.	Basic [1]-[3]	L 9	PA 7	TSIS 6	SIS 6
10	Rectangular membrane. Double Fourier series.	Basic [1]-[3]	L 10	PA 10	TSIS 7	TSIS 7

11	Laplacian in polar coordinates. Circular membrane. Interior Dirichlet problem for a circle.	Basic [1]-[3]	L 11	PA 11	Quiz 3	
12	Laplace transform. Linearity. Shifting theorems. Table of Laplace transforms.	Basic [1]-[3]	L 12	PA 12	TSIS 8	SIS 8
13	Laplace transform for ordinary differential equations and their systems.	Basic [1]-[3]	L 13	PA 13	Quiz 4	
14	Solution of PDEs by Laplace transform.	Basic [1]-[3]	L 14	PA 14	TSIS 9	SIS 9
15	Advanced examples and applications of equations of mathematical physics.	Basic [1]-[3]	L 15	PA 15	End of term	
	Total hours	**135**	**15**	**15**	**15**	**45**

6.2 List of assignments for Student Independent Study

№	Assignments (topics) for Independent study	Hours	Recommended literature and other sources (links)	Form of submission
1	Classifying second order partial differential equations. Reducing to canonical forms.	6	Basic [1]-[3] Supplementary [1][2]	Submission of IHW
2	Fourier series.	6	Basic [1]-[3] Supplementary [1][2]	Submission of IHW
3	Eigenvalue problems.	6	Basic [1]-[3] Supplementary [1][2]	Submission of IHW
4	Eigenfunction expansion method for solving PDEs.	8	Basic [1]-[3] Supplementary [1][2]	Submission of IHW
5	The heat equation and diffusion.	8	Basic [1]-[3] Supplementary [1][2]	Submission of IHW
6	The wave equation.	6	Basic [1]-[3] Supplementary [1][2]	Submission of IHW
7	Laplace equation in cylindrical and spherical coordinates	8	Basic [1]-[3] Supplementary [1][2]	Submission of IHW
8	Solving ordinary differential equzations by Laplace transform	6	Basic [1]-[3] Supplementary [1][2]	Submission of IHW
9	Solving PDEs by Laplace transform	6	Basic [1]-[3] Supplementary [1][2]	Submission of IHW

7. Student performance evaluation system for the course

Period	**Assignments**	**Number of points**	**Total**
1st attestation	**Class work:**	**40**	100
	Regular attendance\Active participation	10	
	Quiz # 1	15	
	Quiz # 2	15	
	Student Independent Study:	**35**	
	Individual Home Work # 1	5	
	Individual Home Work # 2	5	
	Individual Home Work # 3	5	
	Individual Home Work # 4	10	

	Individual Home Work # 5 **Mid term**	10 **25**	
2nd attestation	**Class work:** Regular attendance\Active participation Quiz # 3 Quiz # 4 **Student Independent Study:** Individual Home Work # 6 Individual Home Work # 7 Individual Home Work # 8 Individual Home Work # 9 **End of term**	**40** 10 15 15 **35** 5 10 10 10 **25**	100
Final exam	**Exam**	**100**	100
Total	**0,3*1stAtt+0,3*2ndAtt+0,4*Final**		**100**

*If the number of absences exceeds 20%, student will be automatically scheduled for a Retake (summer semester)

Achievement level as per course curriculum shall be assessed according to the evaluation chart adopted by the academic credit system:

Letter Grade	Numerical equivalent	Percentage	Grade according to the traditional system
A	4,0	95-100	Excellent
A-	3,67	90-94	
B+	3,33	85-89	Good
B	3,0	80-84	
B-	2,67	75-79	
C+	2,33	70-74	Satisfactory
C	2,0	65-69	
C-	1,67	60-64	
D+	1,33	55-59	
D	1,0	50-54	
F	0	0-49	Fail

8. METHODOLOGICAL GUIDELINES

Assessment is administered continuously throughout the course. The students are rated against their performance in **continuous rating** administered throughout the semester (credited 60%) and **summative rating** done during the examination session (credited 40%), total **100%. Continuous rating** is students' on-going performance in class and independent work. Class work is assessed for attendance and active participation (problem solving).

Teaching methodology

Theory classes:

- lectures developing the theoretical aspects of the subject
- practical classes aimed at applying theory to problems.

Workshop classes:

- practical classes in which students solve problems in groups or individually.

SIS (Student Independent Study) comprises topics related problems to be done by students independently and checked in class.

TSIS (Teacher Supervised Student Independent Study) comprises individual homework assignments to be done by students independently and checked by teacher.

Mid-term examination is held in the 8th week of the semester and includes topics 1-7 of the course.
End-of-term examination is held in the last week of the semester and includes topics 8-15 of the course.

Final examination is a computer-based test that consists of multiple choice questions covering all topics of the course.