Al-FARABI KAZAKH NATIONAL UNIVERSITY
FACULTY MECHANICS AND MATHEMATICS
Educational program on specialty «050603-Mechanics»

Approved
at the meeting of Academic Council
of the faculty of Mechanics and Mathematics

Protocol №___from « ____»_____ 2015
Dean of the Faculty _____ Bektemesov M.A.

STATISTICAL MECHANICS

SYLLABUS

2-nd year master students «050603-Mechanics»,
Fall semester, 3 credits

Lecturer/Labs Teacher: Yerzhan Belyayev, Doctor PhD
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Activities under the program of the course is set in the form of lectures. Practical fastening of the lecture materials is carried out in a laboratory studies and IWMT (independent work of a master student with a teacher) in accordance with the schedule and the program. Tasks for IWM (independent work of a master student) and verification of IWM is carried out by lecturer. Midterm exams takes Labs teacher.

Aim of the course. To teach students the fundamentals of Thermodynamics and Statistical Mechanics, the basic research methods, to teach them to understand the basic equations and to introduce the fundamental axioms, hypotheses and modern approach of Thermodynamics and Statistical Mechanics. As a result of studying the course, students should know the basic laws and characteristics of Thermodynamics and Statistical Mechanics.

Objectives of the course. Concept of the course is based on the book "An Introduction to Thermodynamics and Statistical Mechanics", Second Edition by Keith Stowe. This introductory textbook for standard undergraduate (in our case master students) courses in thermodynamics has been completely rewritten to explore a greater number of topics more clearly and concisely. Starting with an overview of important quantum behaviors, the book teaches students how to calculate probabilities in order to provide a firm foundation for later chapters. It then introduces the ideas of "classical thermodynamics" -- internal energy, interactions, entropy, and the fundamental second law. These ideas are explored both in general and as they are applied to more specific processes and interactions. The remainder of the book deals with "statistical mechanics" -- the study of small systems interacting with huge reservoirs.

Learning outcomes. Necessary knowledge in the basics of Thermodynamics and Statistical Mechanics.

General competence:

- instrumental – the ability to assess the methodological approaches to carry out their critical analysis;

- interpersonal – ability to independently develop and deepen their knowledge and acquire new skills in a professional manner; knowledge of a foreign language (English) in an amount sufficient to communicate freely in arbitrary topics;
- system – the ability to plan the steps of solving professional problems and implement them in time; demonstrate independence and original approach to problem solving, the ability to justify and make decisions.

Subject specific competences: owning a deep fundamental theoretical knowledge in the Thermodynamics and Statistical Mechanics.

Prerequisites: "Fluid Mechanics", "Continuum Mechanics", "Differential Equations", "Mathematical Physics", "Thermodynamics", "Statistical Physics".

Post requisites: "Thermodynamics", "Statistical Mechanics", "Statistical Physics".

STRUCTURE AND CONTENT OF THE SUBJECT

Week	Title of the theme	Hour	Grade
1	**Lecture 1.** Introduction. **Lab.1.** Statistics for small systems. **IWM 1.** Systems with many elements.	2 1	14
2	**Lecture 2.** Energy and the first law. **Lab.2.** Internal energy. **IWM 2.** Interactions between systems.	2 1	14
3	**Lecture 3.** States and the second law. **Lab.3.** Internal energy and the number of accessible states. **IWM 3.** Example problem.	2 1	14
4	**Lecture 4.** Entropy and the second law. **Lab.4.** Entropy and thermal interactions. **IWM 4.** Example problem.	2 1	14
5	**Lecture 5.** Constraints. Natural constraints. **Lab.5.** Models. **IWM 5.** Test problems.	2 1	14
6	**Lecture 6.** Choice of variables. **Lab.6.** Special processes. **IWM 6.** Test problems.	2 1	14
7	**Lecture 7.** Engines. **Lab.7.** Diffusive interactions. **IWM 7.** Test problems.	2 1	16
	1st control test	1	**100**
	Midterm exam	1	**100**
8	**Lecture 8.** Classical statistics. Probabilities and microscopic behaviors. **Lab.8.** Kinetic theory and transport processes in gases. **IWM 8.** Test problems.	2 1	12
9	**Lecture 9.** Magnetic properties of materials. **Lab.9.** The partition function. **IWM 9.** Test problems.	2 1	12
10	**Lecture 10.** Quantum statistics.	2	12

	Lab.10. Test problems. **IWM 10.** Test problems.	 1	
11	**Lecture 11.** Quantum gases. **Lab.11.** Test problems. **IWM 11.** Test problems.	2 1	12
12	**Lecture 12.** Blackbody radiation. **Lab.12.** Test problems. **IWM 12.** Test problems.	2 1	12
13	**Lecture 13.** The thermal properties of solids. **Lab.13.** Test problems. **IWM 13.** Test problems.	2 1	12
14	**Lecture 14.** The electrical properties of materials. **Lab.14.** Test problems. **IWM 14.** Test problems.	2 1	12
15	**Lecture 15.** Low temperatures and degenerate systems. **Lab.15.** Test problems. **IWM 15.** Prepare a presentation.	2 1	16
	2nd control test	1	100
	Exam		**100**
	TOTAL		**(1CT+2CT)/2*0.6 +0.1*MT+0.3*EXAM**

LIST OF LITERATURE

Main:

1. Keith Stowe An Introduction to Thermodynamics and Statistical Mechanics // Second Edition, CAMBRIDGE UNIVERSITY PRESS, 2012, ISBN-10 0-521-86557-3, P. 556.
2. Robert H. Swendsen An Introduction to Statistical Mechanics and Thermodynamics// Second Edition, OXFORD UNIVERSITY PRESS, 2012, ISBN 978–0–19–964694–4, P. 401.

Additional:

1. Ф. Рейф, *Статистическая физика*, *Берклеевский курс физики*, том V, М., Наука, 1977.
2. Фейнман Р. *Статистическая механика*. *Курс лекций*. -М. 1975
3. Ландау Л., Лифшиц Е. *Статистическая физика*. -М. 1965.

GUIDLINES

All the assignments must be completed until due date. Students, who could not earn 50% out of 100% during first or second midterm and final, will be able to work off during an additional term. Late assignment is not accepted except for extenuating circumstances (e.g. field trip, hospitalization). Stu-

dent, who failed to meet all kinds of work, is not allowed for passing an exam. In addition, the assessment takes into account the activity and attendance of students during class.

Be tolerant and respect other people's opinions. The objections should be formulated in a correct manner. Plagiarism and other forms of cheating are not allowed. Cheating is not accepted during independent work of student (IWS), midterm and final exam, copying solved problems from others, passing the exam to another student are not allowed also. Student convicted of falsifying any information about the course, any unauthorized upload to the "Intranet" using cheat sheets, will be graded with a final grade «F». For advice on the implementation of IWS, submitting and defending, as well as additional information on the studied material and all the other issues that arose upon studying the course, contact the instructor during his office hours.

Letter grade	Numerical equivalency	% (percentage)	Grading in a traditional way
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	Unsatisfactory
I (Incomplete)	-	-	«The course is incomplete» (this isn't taken into account when calculating the *GPA)*
P (Pass)	-	-	«Passed» (this isn't taken into account when calculating the *GPA)*
NP (No Pass)	-	-	«Not passed» (this isn't taken into account when calculating the *GPA)*
W (Withdrawal)	-	-	«the course is withdrawn» (this isn't taken into account when calculating the *GPA)*
AW (Academic Withdrawal)			Withdrawn because of academic issues (this isn't taken into account when calculating the *GPA)*
AU (Audit)	-	-	«Audit» (this isn't taken into account when calculating the *GPA)*
Att.		30-60 50-100	Attested
Not att.		0-29	Not attested

		0-49	
R (Retake)	-	-	Retaking the course

Considered in department meeting
Protocol № __ from «__» _____

Head of the department of Mechanics _____ Z. Rakisheva

Lecturer _____ Ye. Belyayev