Al-Farabi Kazakh National university
Syllabus
GD 6306; GD 6307; GD 8305 - GAS DYNAMICS

Fall semester 2016 - 2017 academic year

Code of Discipline	name Discipline	Type	Number of hours per week			Number of credits	ECTS
			Lec	Prac	Lab		
	Gas dynamics	OK	1	2	0	3	5

Prerequisites	Fluid Mechanics", "Continuum Mechanics", "Differential Equations", "Mathematical Physics", "Thermodynamics", "CFD".		
Lecturer	**Yerzhan Belyayev, Doctor PhD**	**Office hours**	By timetable of the classes
e-mail	**Yerzhan.Belyaev@kaznu.kz**		
Telephones	8 (727) 377-31-93	**Lecture hall**	By timetable of the classes
Course description	Study of the basics and fundamental principles of Gas Dynamics. Shock waves, different nozzles, propulsion systems. Different types of flow: Kelvin-Helmholtz, Prandtl-Meyer, Fanno, Rayleigh, Dean etc.		
The aim of the course	To teach students the fundamentals of Gas Dynamics, the basic research methods of gas dynamics, to teach them to understand the basic equations and to introduce the fundamental axioms, hypotheses and modern approach in modeling of gas dynamical flows. The purpose of discipline is familiarize students with the basic internal and external flows, which are covered with practical applications. Concept of the course is based on the book "Fundamentals of Gas Dynamics" by Robert D. Zucker and Oscar Biblarz. As a result of studying the course, students should know the basic laws and characteristics of gas dynamics, to be able to recognize and simulate problems in gas dynamics.		
learning Outcomes	Necessary knowledge in the basics of gas dynamics and skills to numerically solve the problems of compressible flows. 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 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.		

<table>
<tr><td>List of literature</td><td>Main:

1. Robert D. Zucker, Oskar Biblarz Fundamentals of Gas Dynamics // Second Edition, John Wiley & Sons, Inc. 2002, ISBN 0-471-05967-6, P. 493.
2. Г. Г. Черный Газовая динамика // Москва «НАУКА» 1988, 424 с.
3. В. П. Стулов Лекции по газовой динамике // Москва ФИЗМАТЛИТ 2004, 191 с.
4. А. Н. Крайко, А. Б. Ватажин, А. Н. Секундов Газовая динамика // Москва ФИЗМАТЛИТ 2001, 761 с.
5. Genick Bar-Meir Fundamentals of Compressible Fluid Mechanics // 7449 North Washtenaw Ave Chicago, IL 60645, P. 399.
6. Г.В.Липман, А.Рошко, Элементы газовой динамики, М., ИИЛ, 1960.
7. Л.Г.Лойцянский, Механика жидкости и газа, М., ГИТТЛ, 1957.
8. Ю. В. Лапин, М. Х. Стрелец Внутренние течения газовых смесей // Москва «Наука» 1989, 366 с.

Additional:

1. Г.Н.Абрамович, Прикладная газовая динамика, М., Наука, 1969.
2. Л.И.Седов, Методы подобия и размерности в механике, М.,Наука, 1987.
3. Я.Б.Зельдович, Ю.П.Райзер, Физика ударных волн и высокотемпературных явлений в газах, М., Наука, 1966.
4. М.А.Лаврентьев, Б.В.Шабат, Проблемы гидродинамики и их математические модели, М.,Наука, 1977.
5. Б.Л.Рождественский, Н.Н.Яненко, Системы квазилинейных уравнений и их приложения к газовой динамике, М., Наука, 1968.
6. Л.Д.Ландау, Е.М.Лифшиц, Гидродинамика, М., Наука, 1986.
7. Н. Ф. Краснов, В. Н. Кошевой, В. Т. Калугин Аэродинамика отрывных течений //Москва «Высшая школа» 1988, 347 с.
8. П. Чжен Отрывные течения // Издательство «Мир», Москва, 1972.</td></tr>
<tr><td>Organization</td><td>Concept of the course is based on the book “Fundamentals of Gas Dynamics” by Robert D. Zucker and Oscar Biblarz. As a result of studying the course, students should know the basic laws and characteristics of gas dynamics, to be able to recognize and simulate problems in gas dynamics.</td></tr>
<tr><td>course Requirements</td><td>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). Student, 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.</td></tr>
<tr><td>evaluation Policy</td><td>Description self study results</td><td>Weigh t</td><td>Description self</td></tr>
<tr><td></td><td>Hometasks
Development of a database project
Programming Project</td><td>35%
10%
15%</td><td>1,2,34,5,6
2,3,4
4,5,6</td></tr>
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	examinations TOTAL	40% 100%	1,2,3,4,5,6
	Your final score will be calculated by the formula below: $\text{Total score of the course} = \frac{PK1 + PK2}{2} \cdot 0{,}6 + 0{,}1ME + 0{,}3FE$ Below are minimum estimates in percent: 95% - 100%: A 90% - 94%: A- 85% - 89%: B+ 80% - 84%: B 75% - 79%: B- 70% - 74%: C+ 65% - 69%: C 60% - 64%: C- 55% - 59%: D+ 50% - 54%: D- 0% -49%: F		
discipline Policy	Appropriate timing of homework or projects may be extended in the event of extenuating circumstances (such as illness, emergencies, emergency, contingency, etc.) in accordance with the University's academic policies. Student participation in discussions and exercises in the classroom will be taken into account in its overall assessment of the discipline. Design issues, dialogue and feedback on the subject matter of discipline are welcomed and encouraged in the classroom, and the teacher in the derivation of the final grade will take into account the participation of each student in the class.		

Schedule discipline

Week	Title of the theme	Hour	Grade
1	**Lecture 1.** Introduction to gas dynamics. Review of elementary principles. **Lab.1.** The system of equations for compressible flows. **IWM 1.** Conservation Laws. Various form of the energy equations.	2 1	14
2	**Lecture 2.** Control volume analysis. **Lab.2.** Test problems. **IWM 2.** Test problems.	2 1	14
3	**Lecture 3.** Introduction to compressible flow. **Lab.3.** Equation of perfect gases in terms of Mach number. **IWM 3.** Example problem.	2 1	14
4	**Lecture 4.** Varying-area adiabatic flow. **Lab.4.** Nozzle operations. **IWM 4.** Diffuser performance. Example problem.	2 1	14
5	**Lecture 5.** Standing normal shocks. **Lab.5.** Supersonic wind tunnel operation. **IWM 5.** Test problems.	2 1	14
6	**Lecture 6.** Moving and oblique shocks. **Lab.6.** Oblique shock analysis: perfect gas. **IWM 6.** Test problems.	2 1	14
7	**Lecture 7.** Shock analysis – general fluid.	2	

	Lab.7. Boundary condition of pressure equilibrium. **IWM 7.** Test problems.	1	 16
	1st control test	1	**100**
	Midterm exam	1	**100**
8	**Lecture 8.** Prandtl-Meyer Flow. **Lab.8.** Analysis of Prandtl-Meyer Flow. **IWM 8.** Test problems.	2 1	12
9	**Lecture 9.** Fanno Flow. **Lab.9.** Correlations with Shocks. **IWM 9.** Test problems.	2 1	12
10	**Lecture 10.** Rayleigh Flow. **Lab.10.** Working equations for perfect gases. **IWM 10.** Test problems.	2 1	12
11	**Lecture 11.** Real gas effects. **Lab.11.** Real gas behavior, equations of state and compressibility factors. **IWM 11.** Test problems.	2 1	12
12	**Lecture 12.** Propulsion systems. **Lab.12.** Propulsion Engines. **IWM 12.** Test problems.	2 1	12
13	**Lecture 13.** Propulsion systems. **Lab.13.** Air-breathing propulsion systems performance parameters. **IWM 13.** Test problems.	2 1	12
14	**Lecture 14.** Propulsion systems. **Lab.14.** Rocket propulsion systems performance parameters. **IWM 14.** Test problems.	2 1	12
15	**Lecture 15.** Engineering applications. **Lab.15.** Simulation software for gas dynamical problems. **IWM 15.** Prepare a presentation.	2 1	16
	2nd control test	1	100

	Exam		**100**

Dean of the Faculty	M.A. Bektemesov
Chairman of the Bureau of the method	F.R. Gusmanova
Head of the department	Z. Rakisheva
Lecturer	Ye. Belyayev