Co-funded by the
Erasmus+ Programme
of the European Union

SUBJECT:	Fluid Mechanics
ECTS CREDITS:	6 ECTS
TEACHERS, UNIVERSITY AND EMAILS:	1. Urazboev Gayrat, (UrSU, gayrat71@mail.ru) 2. Karimov Umid (UrSU, umid.karimov@gmail.com)
RESPONSIBLE TEACHER:	Urazboev Gayrat
LANGUAGE OF INSTRUCTION:	Russian (Urazboev G) English (Karimov Umid)
ACADEMIC COURSE:	2016—17.
NAME OF THE MASTER'S DEGREE:	Master's in Mathematical Engineering.

COURSE AIMS:

- Introducing students to the fundamentals fluid mechanics and its applications in process engineering
- Being able to solve fluid flow problems and design of pipeline and equipment for fluid transport
- Understanding the incompressible inviscid flows, incompressible viscous flows, convective heat transfer
- Understanding the basic principles and analysis of both static and dynamic fluid systems, and perform design calculations on engineering fluid systems
- Being able to apply various mathematical methods to solve the resulting problems, and be able to interpret the mathematical results physically

LEARNING OUTCOMES:

- Demonstrating their understanding of the basic principles of static and fluid systems;
- Performing a basic analysis of static and fluid systems;
- Devising simple solutions to a range of problems in basic fluid flow;
- Working proficiently and effectively in small teams;
- Presenting their understanding and analysis of problems using methodical and clearly demonstrated worked solutions;
- Participating constructively in class discussions and presentations;
- Using appropriating modelling tools to design pipelines and equipment;
- Undertaking basic design calculations of fluid engineering systems;
- Understanding and articulate the principles that are in operation in a range of fluid motive and flow measuring devices.

COURSE SYLLABUS:

I. Fundamental models of fluid dynamics.
   a. Conservation laws for Newtonian fluids.
   b. Equations in non-dimensional form and physical interpretation of the main non-dimensional parameters: Mach, Reynolds, Froude, Prandtl, Peclet, Grashof and Nusselt numbers.
   c. The Pi-theorem and scaling. Derivation of the fluid mechanics main models as limit models in non-dimensional numbers.

II. Incompressible inviscid flows.
   a. Equations of evolution of the vorticity in a perfect fluid.
   b. Study of irrotational and potential flows. Limitations of the potential model.
   c. Examples of potential flows and applications. Some ideas of theory of lift.

III. Incompressible viscous flows.
   a. Some particular solutions of the Navier-Stokes equations in steady state.
   b. Elemental analysis of boundary layers: basic ideas of the techniques of analysis and study of Blasius problem.
   c. Observations on the stability of stationary laminar viscous solutions. Examples of hydrodynamic instabilities.

IV. Turbulent flows.
   a. Kolmogorov scale and some examples.
   b. Some ideas on vorticity dynamics in 3D.
   c. Most used statistical tools in turbulence.
   d. Turbulence kinetic energy equation.
   e. Main models for turbulent flows.

V. Convective heat transfer.
   a. Forced convection. Convective transport in tubes in laminar regime. Flows with high Peclet number. Thermal boundary layer. Correlations. Convective heat transport in turbulent regime. Empirical correlations.
   b. Natural convection. Heat transfer correlations for laminar and turbulent flows. Some examples.

LITERATURE:

- Basic literature:
  - [1] Лойцянский Л. Г. Механика жидкости и газов – М. : Наука, 1978. – 730 с.
  - [2] Ван-Дайк М. Альбом течений жидкости и газов– М. : Мир, 1986. – 184 с.
  - [3] Ландау Л.Д, Лифшиц Е. М. Гидродинамика, — М.: Наука, 1986. — 736 с.
  - [4] Panton, R.L.: Incompressible Flow. Wiley, 1984.
  - [5] White, F.M.: Heat and mass transfer. Addison-Wesley, 1988.
  - [6] Wilcox, D.C.: Turbulence Modelling for CFD. DCW Industries, 1993.
- Further reading:
  - [1] Седов Л. И. Методы подобия и размерности в механике. — М.: Наука, 1981. — С. 31. — 448 с.
  - [2] Falkovich G. Fluid Mechanics, a short course for physicists. — Cambridge University Press, 2011.
  - [3] Gustafson K.E., Introduction to partial differential equations and Hilbert space methods — 3rd ed.,1999
  - [4] Acheson, D.J.: Elementary Fluid Dynamics. Oxford University Press, 1990.
  - [5] Davidson, P. A.: Turbulence, an Introduction for Scientist and Engineers, Oxford Univ. Press, 2004.
  - [6] Kundu, P.K. y Cohen, M.I.; Fluid Mechanics, 2nd ed. Academic Press, 2002.
  - [7] Ockendon, H. y Ockendon, J.R.: Viscous Flow. Cambridge University Press, 1995.
  - [8] Tennekes, H. y Lumley, J.L.: A first course in Turbulence. MIT Press, 1972.
  - [9] White, F.M.: Viscous fluid flow, 3rd ed. McGraw-Hill, 2006.

TEACHING METHOD:

Face-to-face lectures, tutorial and lab classes, online lecture notes, tutorial solutions, peer mentoring, ‘help day’ by tutors/lecturers and selection of textbooks having interactive solutions of numerical problems. Videoconference to all CA partners.

METHOD OF ASSESSMENT:

70% for **Knowledge and understanding**:

- written examination which includes examination on theory taught in the lectures and practical/seminar/laboratory classes

30% for **Practical issues**:

- includes solved exercises on personal studies,

- attendance to the lab/practical/seminar classes
- Oral and written responses based on individual experience
- Applying fluid mechanics in real-life contexts
- Investigating patterns

Method of REASSESSMENT:
70% for **Knowledge and understanding**:
- written examination which includes examination on theory taught in the lectures and practical/seminar/laboratory classes

30% for **Practical issues**:
- written examination which includes solved exercises during the reassessment examination

STUDENT WORKLOAD:

On-site work at the classroom (attendance to classes and participation on them) = 60 hours.
Lecture hours: 2 hours per week
Practical/Lab hours: 2 hours per week
Mid term exam: 2 academic hours
Final exam: 2 academic hours

Self-study (autonomous study, doing exercises, programming, recommended readings) = 54 hours.

RECOMMENDATIONS:

Fluid mechanics is a visual subject. While older than dirt, these videos (National Committee for Fluid Mechanics Films) are well-respected and incredibly helpful to explain all types of concepts by engineers, for engineers. They can be a bit theoretical at times, but still have great visuals.

OTHER COMMENTS: