**Syllabus**

**I semester 2017 Academic year**

Academic course information

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| --- | --- | --- | --- | --- | --- |
| Discipline’s code | Discipline’s title | Type | No. of hours per week | Number of credits | ECTS |
| Lect. | Pract. | Lab. | IWS |
| PG 5302 | Subterranean Hydrodynamics  |  | 1 |  | 1 | 1 | 2 |  |
| Lecturer  | Berdenova Bakytnur Amanbayevna, PhD student. | Office hours | Tuesday 17:00-19:50 |
| e-mail | E-mail: bakytnur.berdenova@gmail.com |
| Telephone number | Telephone: +7(702)232 08 66 | Auditory | 106 |
| Assistant  | The same person | Office hours |  |
| e-mail | E-mail:  |
| Telephone number | Telephone:  | Auditory |  |

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| --- | --- |
| Academic presentation of the course | **Type of university**:**Aim of course:** The aim of the course is to give the students the basics of "Underground Hydrodynamics", introduce with basic concepts and terms of flows in porous media, properties of rocks, teach them to derive the basic equations and familiarize them with the basic axioms, hypotheses and modern approaches in modeling underground hydrodynamics problems. |
| Prerequisites | * Fundamentals of Differential equations
* Equations of mathematical Physics
* Continuum Mechanics
* Numerical Methods
* Fluid Mechanics
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| Post requisites | - |
| Information resources  | **literature**:1. J.Bear, A. Verruijt. Modeling Groundwater Flow and Pollution. Holland.: Reidel Publishing Company, 1990 – 414 pp.
2. J.Bear. Dynamics of Fluids in Porous Media. USA, 2014
3. Tarek Ahmed. Reservoir Engineering. USA, 2011
4. Полубаринова-Кочина П.Я. Теория движения грунтовых вод. М.: Наука, 1977. – 664 стр.
5. Коллинз Р. Течение жидкостей через пористые материалы. Мир: - 1964.
6. Шестаков В.М. Динамика подземных вод. Изд-во Московского университета, 1979 г.
7. Zoltan E. Heinemann. Textbook series; Volume1: Fluid flow in porous media. Leoben, 2005 – 204 pp.
8. Чарный И.А. Подземная гидрогазодинамика. М.:1963
9. S11 Ground water flow and well abstraction unit. Instruction manual. –Armfield, 2011.
10. S12 Advanced Environmental Hydrology System. Instruction manual. –Armfield, 2014
11. S1 Drainage and Seepage Tank. Instruction manual. –Armfield, 2013
12. O. Coussy, Poromechanics, Wiley, 2004.
13. R. deBoer, Trends in Continuum Mechanics of Porous Media, Springer, 2005.
14. J. Bear, Dynamics of Fluids in Porous Media, Dover, 1972.
15. L. Dake, Fundamentals of Reservoir Engineering, Elsevier, 1978.
16. K. Aziz and A. Settari, Petroleum Reservoir Simulation, 1979.

**Internet-resources:**  |
| Academic policy of the course in the context of university moral and ethical values | **Academic Behavior Rules:** 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.**Academic values:** |
| Evaluation and attestation policy | **Criteria-based evaluation:** Final evaluation of the discipline Here PK1, PK2 – assessment boundary control (total current control),MТ – estimates for Midterm Exam;ИК – evaluation of the final control (examination during the session).Total score is calculated on the discipline and rounded in the “Univer” automatically.**Summative evaluation:**  |

Calendar (schedule) the implementation of the course content**:**

|  |  |  |  |
| --- | --- | --- | --- |
| Week / date | Topic title (lectures, practical classes, Independent work of students) | Number of hours | Maximum score |
| 1 | 2 | 3 | 5 |
| 1 | Lecture 1. The Porous medium. Fundamentals of rock properties. Porosity. Absolute Porosity. Effective Porosity. Permeability. Absolute, Effective and Relative Permeability. Saturation. | 2 |  |
| Laboratory work 1. Problem solving | 1 | 8 |
| IWS 1. The range of Validity of Darcy Law. | 1 | 6 |
| 2 | Lecture 2. Capillary effect, interfacial surface tension, wettability, contact angle, imbibition and drainage, capillary pressure curves, aeration and saturation zones in unconfined aquifers, water table. | 2 |  |
| Laboratory work 2. Problem solving | 1 | 8 |
| IWS 2. Heterogeneity and Anisotropy. Equations for effective permeability calculation of heterogeneous porous media. | 1 | 6 |
| 3 | Lecture 3. Rock (soil) compressibility, moisture content and soil strength, soil structure and density, Darcy law, Klinkenberg effect, effective pore radius, steady filtration of incompressible fluid. Initial and boundary conditions.  | 2 |  |
| Laboratory work 3. Problem solving | 1 | 8 |
| IWS 3. Nonlinear Equations of Motion. | 1 | 6 |
| 4 | Lecture 4. Fundamentals of Reservoir fluid flow. Types of fluids. Flow regimes. Reservoir geometry. Linear flow of fluids. Radial flow of fluids.Spherical and Hemispherical Flow. Dupuit equation. | 2 |  |
| Laboratory work 4. Problem solving | 1 | 8 |
| IWS 4. Flow regimes: Steady-state flow; Unsteady-state flow; Pseudosteady-state flow | 1 | 6 |
| 5 | Lecture 5. Contaminant Hydrogeology, sources and types of contaminants, conservative and reactive solutes, convective transport, diffusive transport, mass conservation of a species. | 2 |  |
| Laboratory work 5. Problem solving | 1 | 8 |
| IWS 5. Boundary conditions for precipitation seepage problems into the soil and urban runoff. | 1 | 6 |
| 6 | Lecture 6. Two-phase flow basics. Definitions of end point saturations, saturation distribution, differential form of the Darcy-law, oil and gas formation volume factors. | 2 |  |
| Laboratory work 6. Problem solving | 1 | 8 |
| IWS 6. Determination and derivation of flowrate equations  | 1 | 6 |
| 7 | Lecture 7. Linear flow with constant production rate. Steady state filtration in a radial system. The infinite radial system with constant pressure at the interior boundary.  | 2 |  |
| Laboratory work 7. Problem solving | 1 | 9 |
| IWS 7. Water – gas coning near wellbore | 1 | 7 |
|  | **1st control work** |  | **100%** |
| 8 | **Midterm Exam** |  | **100%** |
| 9 | Lecture 9. Types of Fluids: Incompressible fluids; Slightly compressible; Compresssible fluid. Steady flow of Elastic fluid in Porous Media. | 2 |  |
| Laboratory work 9. Problem solving | 1 | 8 |
| IWS 9. Leibenson Function. | 1 | 6 |
| 10 | Lecture 10. Buckley-Leverett Solution, Influence of gravity. Impervious boundary. Recharge boundary. Production and injection wells.  | 2 |  |
| Laboratory work 10. Problem solving | 1 | 8 |
| IWS 10. Methods for unwanted water control in production wells of depleting oil reservoirs. | 1 | 6 |
| 11 | Lecture 11. Piston-like displacement. The mobility ratio. Flow of Immiscible Fluids. Propagation of a displacement front. | 2 |  |
| Laboratory work 11. Problem solving | 1 | 8 |
| IWS 11. Steady flow of fluid in deformable fractured layer. | 1 | 6 |
| 12 | Lecture 12. Hydrodynamic Dispersion. Definition. Parameters of Dispersion. Molecular diffusion. | 2 |  |
| Laboratory work 12. Problem solving | 1 | 8 |
| IWS 12. Coefficient of Dispersion. Mechanical dispersion and Diffusion. | 1 | 6 |
| 13 | Lecture 13. Hydrodynamical fundamentals of the theory of groundwater migration. The convective transport. Diffusive transport. (Шестаков) | 2 |  |
| Laboratory work 13. Problem solving | 1 | 8 |
| IWS 13. The dispersion of liquids interface in a homogeneous aquifer. | 1 | 6 |
| 14 | Lecture 14. Macro dispersion in a heterogeneous environment. | 2 |  |
| Laboratory work 14. Problem solving | 1 | 8 |
| IWS 14. Methods for determination of migration parameters. | 1 | 6 |
| 15 | Lecture 15. Method of hydrogeological calculation of groundwater pollution. | 2 |  |
| Laboratory work 15. Problem solving | 1 | 9 |
| IWS 15. Methods for determination of migration parameters. | 1 | 7 |
|  | **2nd control work** |  | **100%** |
|  | **Exam** |  | **100%** |
| *Note: Independent work of a student with a teacher is planned at 7 hours per semester. The syllabus is entered on the weeks specified by the teacher as assignments and / or consultations)* |

Lecturer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Chairman of the Faculty Methodical Bureau \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_