| Name of subject | Pumps, Fans and Compressors (ECTS 10) |
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| Subject/module code | NVK35610 |
| Science taught semester (s). | 5th and 6th semesters |
| Responsible teacher | Xolbutayev B., Associate Professor; Safarova M., Assistant, "Engineering Communications" Department |
| Education language | Uzbek |
| Connection to the curriculum | Compulsory |
| Training hours (this including independent education) | **Total hours – 300.**<br>**Audience training hours – 120.**<br>Lecture training hours – 60 (5th semester – 30, 6th semester – 30)<br>Laboratory training hours – 30 (5th semester – 14, 6th semester – 16)<br>Practical training hours – 30 (5th semester – 16, 6th semester – 14)<br>**Independent education – 180 hours (5th semester – 60, 6th semester – 120)** |
| ECTS | 10 (5th semester – 4, 6th semester – 6) |
| The purpose and tasks of subject / learning outcomes | **The purpose of teaching the course –** to develop in students professional competences in selecting pump units for drinking water supply systems, choosing their class and methods of operation according to the type of settlement and industrial enterprise, and in the safety rules for operating pump units.<br>**The task of the course is** that the student: studies the development, history and prospects of the technical field of pumps and fans; obtains information on improving the performance of pumps and fans and on the types and application of regulatory documents; studies the main and operational parameters of pumps and fans, hydraulic structures and their facilities and equipment; calculates the dimensions of pumps and fans and plots their characteristics while complying with occupational safety requirements; and learns to develop process charts.<br>**Prerequisites:** Physics and Mathematics; an understanding and knowledge of the introduction to the specialty, water supply and wastewater disposal systems, modern methods and tools of engineering drawing and design and their hardware and software, and automated control and design systems.<br>**Learning outcomes:**<br>1. Analyses technological processes in the water supply system.<br>2. Is able to select the type of pump units.<br>3. Develops the technology for installing pump units.<br>4. Uses pump units efficiently in water supply.<br>5. Carries out quality control.<br>6. Ensures occupational safety. |
| Course content (topics) | **I. Main Theoretical Part (Lecture Sessions)**<br>**Semester V**<br>**Topic 1:** Introduction. General concepts of pumps, fans and compressors.<br>**Topic 2:** Classification of pumps and fans according to their principle of operation. Classes of dynamic and positive-displacement pumps and their operating principles.<br>**Topic 3:** Types of vane pumps. Design and operating principle of vane pumps.<br>**Topic 4:** Centrifugal pumps. Design and operating principles of centrifugal pumps.<br>**Topic 5:** Diagonal (mixed-flow) pumps. Design and operating |

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| | principle of diagonal pumps.<br>**Topic 6:** Axial pumps. Design and operating principles of axial pumps.<br>**Topic 7:** Types of friction pumps. Design and operating principles of friction pumps.<br>**Topic 8:** Vortex and jet pumps. Their main parameters, design and operating principles.<br>**Topic 9:** Piston and plunger pumps. Their main parameters, design and operating principles.<br>**Topic 10:** Types of rotary pumps. Design and operation of rotary pumps.<br>**Topic 11:** General information on pumps and pumping stations used in water supply and sewerage systems.<br>**Topic 12:** Cavitation in pump units and pumping stations.<br>**Topic 13:** General concepts of pumping stations and their structures.<br>**Topic 14:** Determination of the main dimensions of pumping station buildings.<br>**Topic 15:** Types of pumping station buildings and the requirements for them.<br>**Semester VI**<br>**Topic 16:** Suction and pressure pipelines of pumping stations.<br>**Topic 17:** Parallel and series operation of pumps.<br>**Topic 18:** Selection of the main pumps.<br>**Topic 19:** Equipment and fittings of the technical and utility service systems of pumping stations.<br>**Topic 20:** Pumping stations for rural water supply and wastewater disposal.<br>**Topic 21:** Mobile pumping stations.<br>**Topic 22:** Mechanical power transmissions from the motor to the pump.<br>**Topic 23:** Control and measuring instruments and automation equipment.<br>**Topic 24:** Mechanical equipment and fittings.<br>**Topic 25:** Technical and economic calculations at pumping stations.<br>**Topic 26:** Concepts of fans.<br>**Topic 27:** Types of fans.<br>**Topic 28:** Concept of the working designs of centrifugal fans.<br>**Topic 29:** Theoretical characteristics of fans and the law of proportionality.<br>**Topic 30:** Mechanical effect of particles contained in gases on fans.<br>**II. Instructions and recommendations for organizing laboratory exercises.**<br>During laboratory sessions, students develop practical skills and competencies in measuring various parameters of physical processes, conducting experiments, performing calculations, and drawing tables and graphs. The recommended topics are selected based on available opportunities and conditions.<br>**Recommended topics for laboratory work (5th semester):**<br>1. Study of safety engineering in the operation of pump units. (2 hours)<br>2. Study of the procedure for starting and stopping a pump. (4 hours)<br>3. Determination of the flow and head of a pump. (4 hours)<br>4. Determination of the head–flow characteristic of a pump. (4 hours)<br>**Recommended topics for laboratory work (6th semester):**<br>5. Study of the operation of pumps connected in parallel and in series. (4 hours)<br>6. Study of the main equipment and operating scheme of a pumping station. (4 hours) |

7. Determination of the efficiency of a pump. (4 hours)

8. Study of the design and operating principle of a centrifugal pump. (4 hours)

**III. Practical training instructions and recommendations**

The teacher's preparation for a practical training session begins with the study of preliminary documents (curriculum, thematic plan, etc.) and ends with the development of a lesson plan. The teacher should have an idea of the goals and objectives of the practical training session, the amount of work that each student must perform.

Methodological guidelines are the main methodological document of the teacher in preparing and conducting practical training sessions.

The purpose of the practical training session is to understand the theory, acquire skills. It is to consciously apply it in educational and professional activities, and to develop the ability to confidently form one's own point of view.

**The following topics are recommended for practical training:**

**Semester V**

1. Selection of the pump type and of the general universal characteristic for its model on the basis of given values. (2 hours)

2. Study of the designs, elements and main indicators of various types of pumps and construction of their characteristics. (2 hours)

3. Calculation of pump efficiency, reduced rotational speed, reduced flow and specific speed. (2 hours)

4. Determination of the head losses of a pump due to local resistances. (2 hours)

5. Construction of the operating characteristic of a pump. (2 hours)

6. Calculation of the suction lift and cavitation value and construction of their characteristics. (2 hours)

7. Determination of the impeller diameter of a pump. (2 hours)

8. Parallel and series operation of several pumps with different characteristics. (2 hours)

**Semester VI**

9. Calculation of the total head loss in a pumping station. Calculation of the diameter and length of suction and pressure pipelines. (2 hours)

10. Calculation of the diameter and length of suction and pressure pipelines. (2 hours)

11. Selection of an electric motor for a pump. (2 hours)

12. Circulation, booster and mobile pumping stations. Study of their designs. (2 hours)

13. Calculation of the total head loss in a pumping station. (2 hours)

14. Efficiency of fans. (2 hours)

15. Calculation of fan pressure. (2 hours)

**IV. Independent learning and independent work.**

Independent learning competence serves to support students' independent self-development and increase the effectiveness of professional activities. Students perform independent work on their mobile devices under the guidance of a teacher in a traditional or electronic form.

**Recommended topics for independent study:**

**Semester V**

1. History of mechanical water lifting in the world and in the Republic of Uzbekistan. (6 hours)

2. Importance of the pumps used in the world and in the Republic of Uzbekistan. (6 hours)

3. Pumps for pumping silt and sediments. (6 hours)

4. Fields of application of dynamic pumps. (6 hours)

5. Fields of application of positive-displacement pumps. (6 hours)

6. Fields of application of vertical pumps. (6 hours)

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| | 7. Fields of application of horizontal pumps. (6 hours)<br>8. Borehole pumps, their types and designs. (6 hours)<br>9. Fields of application of water supply pumps. (6 hours)<br>10. Fields of application of wastewater pumps. (6 hours)<br>**Semester VI**<br>11. Types and kinds of pumping stations. (12 hours)<br>12. Control and measuring instruments of pumping stations. (12 hours)<br>13. Requirements for the automation of pumping stations. (12 hours)<br>14. Main hydromechanical and power equipment of pumps. (12 hours)<br>15. Auxiliary equipment: pump and compressor units, lifting mechanisms, ventilation, heating networks, repair bay, screens. (12 hours)<br>16. Mobile pumping stations. (12 hours)<br>17. Special pumping stations and their application by sector. (12 hours)<br>18. Pumping stations for rural water supply and wastewater disposal. (12 hours)<br>19. Water hammer in pressure pipelines and measures against it. (12 hours)<br>20. Types and structure of pumping station buildings. Block, compartment and above-ground pumping station buildings. Shapes of pumping station buildings. (12 hours) |
| Exam form | Written |
| Teaching/learning and examination requirements | **Teaching technologies and methods:** lectures; interactive case studies; seminars (logical thinking, rapid question-and-answer sessions); group work; giving presentations; individual projects.<br>Full mastery of the theoretical and methodological concepts of the course, the ability to present the results of analysis correctly, independent reasoning about the processes being studied, completion of the tasks and assignments set in the current and midterm forms of assessment, and submission of the assessment task for the final assessment.<br>When drawing up final exam questions, deviations from the content of the discipline program are not allowed. The bank of final exam questions for each discipline is discussed at the meeting and approved by the head of the department.<br>No later than 1 week before the start of the final control, tickets signed by the head of the department, enclosed in an envelope, are sealed by the Dean's office and opened 5 minutes before the start of the exam in the presence of students. Final exam duration is 80 minutes. Answers to final exam questions are recorded in copybooks with the seal of the Dean's office. After completion of the final work, the work is immediately encrypted by a representative of the Dean's office, and the copybooks are handed over to the commission for verification. From the moment of completion of the final exam, a period of 72 hours is allotted for checking and posting the results on the electronic platform.<br>The teacher who taught the students in this discipline is not involved in the process of conducting the exam and checking the students' answers.<br>Student(s) who are dissatisfied with the final exam results may submit a written or oral appeal within 24 hours of the publication of the final exam results. Complaints submitted after 24 hours from the publication of the final exam results will not be accepted. |
| Scope of assessment criteria and procedure | CURRENT CONTROL<br>Purpose: Determining and assessing the student's level of knowledge, practical skills, and competencies on course topics.<br>Instructions: The student's activity in daily classes is assessed |

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| | through the student's mastery of course topics, as well as constructively interpreting and analyzing the educational material, developing module-specific skills, acquiring practical skills (in terms of quality and the specified number) and competencies, solving problem situations aimed at applying professional practical skills, working in a team, preparing presentations, etc.<br>Current control form: Activity in lessons Preparing educational materials Working with sources within the subject Using educational technologies Working in a team Preparing presentations Working with projects.<br>MIDTERM CONTROL<br>Purpose: Assessing the student's knowledge and practical skills and level of mastery of lecture material after completing the relevant section of the course.<br>Form and procedure of intermediate control: Midterm examination is held during the semester during the training sessions after the completion of the relevant module of the curriculum of the subject. Midterm examination is held once in written form within the framework of this subject. Midterm examination questions cover all topics of the subject.<br>INDEPENDENT LEARNING<br>Purpose: Independent learning is aimed at fully covering the content of this course, expanding the theoretical knowledge acquired, and establishing independent learning activities for students.<br>Form and procedure of independent education: independent work assignments are completed in the form of an educational project, presentation, case study, problem solving, information search, digest, colloquium, essay, article, abstract, etc. Completed assignments for independent study are placed in the electronic system and checked based on the anti-plagiarism program and evaluated by the subject teacher.<br>In this case, the uniqueness of the completed assignment should not be less than 60%, otherwise the assignment will not be accepted for assessment. The number of independent work assignments, depending on the nature of the subject, should not be less than 3 for one subject (module). Independent work assignments account for 60% of the points allocated for current and intermediate control.<br>FINAL CONTROL<br>Purpose: The final examination is held at the end of the semester to determine the level of mastery of the student's theoretical knowledge and practical skills in the relevant subject. The final examination is held at a specified time according to the examination schedule created by the Registrar's Office on the electronic platform.<br>Requirements: The student must have passed the current control, intermediate control and independent learning assignments by the deadline for the final control type in the relevant subject. A student who has not passed the current control, intermediate control and independent learning assignments, as well as who has received a score in the range of "0-29.9" for these assignments and control types, is not included in the final control type. Also, a student who has missed 25 percent or more of the classroom hours allocated to a subject without a reason is excluded from this subject and is not included in the final control type and is considered not to have mastered the relevant credits in this subject. A student who has not passed or was not included in the final control type and has received a score in the range of "0-29.9" for this type of control is considered to be an academic debtor.<br>Final control form: The final examination in this subject will be conducted in written form. If the final examination is conducted in written form, the requirements for assessment must also be reflected. |

Criteria for assessing student knowledge

| 5 grade | 100 points | | Assessment criteria |
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| 5 | 90-100 | Excellent | When a student is considered to be able to make independent conclusions and decisions, think creatively, observe independently, apply the knowledge he has gained in practice, understand, know, express, and narrate the essence of the subject, and have an idea about the subject. |
| 4 | 70-89,9 | Good | When the student is considered to be able to observe independently, apply the knowledge he has gained in practice, understand, know, express, and narrate the essence of the subject, and has an idea about the subject. |
| 3 | 60-69,9 | Satisfactory | When the student is found to be able to apply the knowledge he has gained in practice, understands, knows, can express, and narrate the essence of the subject, and has an idea about the subject. |
| 2 | 0-59,9 | Unsatisfactory | When it is determined that the student has not mastered the science program, does not understand the essence of the subject, and does not have an idea about the science. |

Course assessment criteria and procedure

| Assessment type | Total points allocated | Control (task) form | Distribution of points | Qualifying score |
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| Current assessment | 30 points | System tasks | 20 points (divided by the number of tasks) | 18 points |
| | | Student activity (in seminars, practical, laboratory classes) | 10 points | |
| Midterm assessment | 20 points | Supervision: Written work | 10 points | 12 points |
| | | System tasks | 10 points (divided by the number of tasks) | |
| Final assessment | 50 points | Written assignment (5 questions) | 50 points (10 points per question) | 30 points |
| * Note: 60% of the points allocated for current and intermediate control are allocated to independent work assignments. Independent work assignments are evaluated as system assignments through the electronic platform. | | | | |

Recommended Literature

**Main literature:**

1. Musayev Sh.M. “Pumps and Pumping Stations”. Textbook, 2020/12/02. Tashkent: Lesson press. (in Uzbek)

2. Meliyev B.O‘. “Engineering Equipment of Buildings”. Textbook for higher education institutions. Jizzakh, 2023. 257 p. (in Uzbek)

3. Qutlimurodov U.M. “Water Supply and Wastewater Disposal Systems”. Study guide. “Minus design group” LLC, 2021. 210 p. (in Uzbek)

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| | 4. Sultonov A. “Use and Protection of Water Management”. Study guide for higher education institutions. Jizzakh, 2023. 157 p. (in Uzbek)<br>5. Saydullayev S.R. “Engineering Communications of Buildings”. Textbook. Jizzakh, 2022. 246 p. (in Uzbek)<br>**Additional literature**<br>6. Mukhammadiev M.M., Nosirov F.J., Paluanov D.T., Djuraev Q.S., Juraev S.R. Methodological guide for laboratory work on the operation of hydropower installations. Tashkent: TSTU, 2013. (in Uzbek)<br>7. Omonov M. Welding Technologies. – Tashkent: Fan va texnologiya, 2021. – 212 p. (in Uzbek)<br>8. Xoliqov A.A. Lecture notes on the course “Pumps, Fans and Compressors”. Bukhara: Texnotasvir, 2019. 140 p. (in Uzbek)<br>9. Baumann H.D. Control Valve Primer: A User’s Guide. 4th Edition. 2024.<br>10. Menon E.S., Menon P.S. Working Guide to Pumps and Pumping Stations: Calculations. 2014.<br>11. Current regulatory documents of the Republic of Uzbekistan in the field of water supply.<br>**Internet resources:**<br>1. www.gov.uz – Government portal of the Republic of Uzbekistan.<br>2. www.lex.uz – National database of legislation of the Republic of Uzbekistan.<br>3. https://t.me/archbookuz |