Course title	Refrigeration Supply (ECTS 4)
Subject/module code	ST3604
Semester(s) in which the course is taught	6th semester (2026–2027 academic year)
Assigned instructor	Pirnazarov I., acting associate professor, Department of Engineering Communications
Language of instruction	Uzbek
Course type	Compulsory
Study workload (including independent study)	**Total workload – 120 hours** **Contact hours – 48** Lecture hours – 24 Laboratory hours – none Practical class hours – 24 **Independent study – 72 hours** Course project – none
ECTS	4
Course aims and objectives / learning outcomes	**The main aim of teaching the "Refrigeration Supply" course is to provide students with theoretical and practical knowledge of the methods of producing artificial cold, and of the design, operating principles, calculation fundamentals and operation of refrigerating machines and installations, as well as of their efficient use in industry, agriculture and the domestic sector. The aim of the course also includes developing skills in designing and using energy-efficient and environmentally safe refrigeration systems.** **The objectives of the course are to teach the theoretical foundations of refrigeration engineering and refrigeration processes; to explain the design and operating principles of refrigerating machines and installations; to teach methods of calculating, selecting and designing refrigeration systems; to teach the properties of refrigerants and the criteria for selecting them; and to develop skills in the installation, commissioning and maintenance of refrigeration systems. The course also covers the application of energy-efficient, environmentally safe and modern refrigeration technologies and ways of improving the reliability and efficiency of refrigeration systems.** **Prerequisites:** **1. Knowledge of the fundamentals of physics, thermodynamics and heat engineering.** The student should have basic theoretical knowledge of heat transfer, thermodynamic processes, the gas laws, pressure, temperature, energy exchange and the physical properties of substances. This knowledge serves as the basis for understanding refrigeration cycles and the processes of producing cold. **2. Knowledge of engineering mathematics and the fundamentals of technical drawing.** The student should have basic skills in performing mathematical calculations, reading technical drawings, analysing schematic diagrams of refrigeration systems and carrying out engineering calculations. This knowledge is important for selecting refrigeration equipment, determining system parameters and design work. **Learning outcomes:** **Professional competencies:** **1. Competence in designing refrigeration supply systems.** Is competent to calculate cooling loads, determine the main parameters of refrigeration systems and design refrigeration supply systems in accordance with regulatory documents. **2. Competence in selecting and operating refrigeration equipment.** Is competent to select refrigerating machines, compressors, condensers, evaporators, pumps and other equipment on the basis of their technical characteristics, and to install, adjust, test and operate them.

	3. Competence in ensuring energy efficiency and environmental safety. Is competent to analyse the energy efficiency of refrigeration supply systems, use modern refrigerants in line with environmental requirements, apply energy-saving technologies and make engineering decisions that ensure the reliable operation of the systems. **Skills:** **4. Skill in calculating refrigeration systems.** Is able to calculate cooling loads, refrigerating capacity, refrigerant flow rate and the main technical parameters of refrigeration supply systems using engineering methods. **5. Skill in selecting refrigeration equipment and designing systems.** Masters the selection of compressors, condensers, evaporators, throttling devices, pumps and other refrigeration equipment, the reading of process flow diagrams and the design of refrigeration systems. **6. Skill in installing and operating refrigeration systems.** Has practical skills in installing, commissioning, adjusting and testing refrigeration supply systems, detecting faults, carrying out maintenance and ensuring safe operation.
Course content (topics)	**I. Main theoretical section (Lectures) – 24 hours** **Topic 1**: Introduction to the course "Refrigeration Supply". Classification of refrigerants. (2 hours)** Introduction. A brief history of the development of refrigeration engineering and its close relationship with other disciplines. [1, 2] **Topic 2: The ozone layer and the causes of its depletion. (2 hours)** General concepts of the Earth's ozone layer. Causes and consequences of the depletion of the atmosphere's protective layer. [3, 4] **Topic 3: Selecting indoor and outdoor design air parameters for the design of refrigeration systems. (2 hours)** Selecting indoor and outdoor design air parameters for ventilation and air-conditioning systems on the basis of QMQ and ShNQ (national building codes), industry standards, standards and technical specifications. [3, 4] **Topic 4: Fundamentals of producing artificial cold. (4 hours)** Methods of cooling; cooling with ice. [3, 4] **Topic 5: Alternative cooling means. (2 hours)** Working fluids of refrigerating machines. [2, 3] **Topic 6**: HVAC operational control. (2 hours)** Control of the components of ventilation and air-conditioning systems. [1, 2] **Topic 7: Recommendations for the servicing of small refrigeration units and air-conditioning systems. (2 hours)** Cold rooms. Air conditioners. [2, 3] **Topic 8: Recommendations for the installation and maintenance of commercial and industrial refrigeration and air-conditioning systems. (2 hours)** General operating and maintenance procedures. [1, 2] **Topic 9: Alternative refrigerants. (2 hours)** Working fluids of refrigerating machines. Main properties and environmental performance of refrigerants for vapour-compression machines. [1, 2] **Topic 10: Special operations in the servicing of refrigeration equipment. (2 hours)** Checking the cooling-water flow, draining the cooling-water system and refilling it with cooling water. [3, 4] **Topic 11: Main faults and methods of eliminating them. (2 hours)** Refrigerating machines and air-conditioning units. [1, 3] ** Topics drawn from the curricula of universities ranked in the TOP-300 of the QS and THE rankings: Topic 1 – National University of

	Singapore (NUS), "Thermal Environmental Engineering" (psychrometrics, cooling load calculations, air-conditioning systems, vapour compression refrigeration, energy performance analysis); Topic 6 – Delft University of Technology (TU Delft), "HVAC Operation & Control" (installation of systems and technologies with high-temperature thermal and humidity treatment). **II. Guidelines and recommendations for practical classes – 24 hours** Practical classes consolidate the theoretical material of the lectures and develop students' skills in calculating, selecting, installing and maintaining refrigeration and air-conditioning systems, as well as in applying the regulatory requirements for ozone-depleting substances and refrigerants. **Recommended practical topics (2 hours each):** 1. International and national legislative framework on ozone-depleting substances. 2. Main types of harmful substances and their effects on the human body. 3. Determining the amount of harmful substances released in a room. 4. Design properties and environmental performance of the main refrigerants of vapour-compression machines. 5. Preventing refrigerant emissions to the atmosphere. 6. Maintenance and repair. 7. Identifying types of air flow. 8. Air exchange arrangements in buildings. 9. Insulation materials for refrigeration systems. 10. Installation of refrigeration systems. 11. Filters. 12. Air-conditioning units. **III. Laboratory classes** Laboratory classes are not provided for in the curriculum of this course. **IV. Independent study – 72 hours** Independent study develops students' ability to learn autonomously, to work with scientific and technical literature, regulatory documents and electronic resources, and to apply the knowledge gained in professional activity. Assignments are completed under the teacher's guidance in traditional or electronic form. **Topics recommended for independent study (6 hours each):** 1. Main types of refrigeration systems and their applications. Types of refrigeration systems (compression, absorption, evaporative) and their applications in industry and the domestic sector. 2. The role of freons in refrigeration systems and their environmental impact. Properties and types of freons used as refrigerants and their environmental impact. 3. Operating principle of compression refrigeration systems. Structure of the compression refrigeration cycle, its working mechanism and ways of improving its efficiency. 4. Advantages and disadvantages of absorption refrigeration systems. Design, operating principle and fields of application of absorption refrigeration systems. 5. Heat transfer processes in refrigeration systems. Physical processes of heat transfer in the condenser and evaporator and ways of improving their efficiency. 6. Energy-saving technologies in refrigeration systems. Methods of reducing energy consumption and modern technologies in refrigeration systems. 7. Automated control systems for refrigeration systems. Application

	of automation and monitoring systems in refrigeration systems. 8. Thermodynamic properties of refrigerants and selection criteria. Properties and thermodynamic parameters of refrigerants and their appropriate selection. 9. The importance of thermal insulation materials in refrigeration systems. 10. Design and operating principle of air-conditioning systems. Design, working mechanism and technical characteristics of domestic and industrial air conditioners. 11. Faults in refrigeration systems and measures against them. Typical faults in refrigeration systems, diagnostics and repair methods. 12. Cryogenic refrigeration systems and their applications. Operating principle, applications and importance of cryogenic systems in special industrial sectors. **V. Teaching technologies and methods** – lectures; – interactive case studies; – seminars (logical thinking, rapid question-and-answer sessions); – group work; – presentations; – individual projects; – team projects for joint work and defence.
Student assessment	Student assessment is based on the level of mastery of the learning materials during the semester and final assessment (tests, assignments, and written and oral work). Throughout the "Refrigeration Supply" course, students are assessed on a 100-point scale. Of this total, 50 points are allocated to current and midterm assessment (60% of these 50 points for ongoing assessment and independent study, and 40% for the midterm assessment), while 50 points are allocated to the final assessment. Students whose combined current and midterm score is below 30 points are not admitted to the final examination. A student who obtains 30 or more points in the final assessment is considered to have passed the course. **Assessment criteria:** **a) A grade of "5" (excellent) requires the student to:** – fully explain the essence and content of the course; – present the topics of the course in a scientific and logically consistent manner, without scientific errors or inaccuracies; – have a clear understanding of the theoretical or practical importance of the course material; – demonstrate the ability to think independently and freely within the scope of the course; – give clear and concise answers to the questions asked; – have a thoroughly prepared set of lecture notes; – complete independent assignments fully and accurately; – have mastered all the practical skills and competencies; – be able to apply theoretical knowledge in various situations; – take a systematic approach and maintain continuity. **b) A grade of "4" (good) requires the student to:** – understand the essence and content of the course and present its topics without scientific or logical inaccuracies; – understand the practical importance of the course content; – complete the tasks and assignments for the course within the scope of the syllabus; – give correct answers to the questions asked on the course; – have a well-prepared set of lecture notes for the course; – complete the independent assignments for the course in full; – have made an effort to master all the practical skills and

	competencies. **c) A grade of "3" (satisfactory) requires the student to:** – have a general understanding of the course; – cover the topics of the course within a narrow scope, allowing some inaccuracies in presentation; – complete the independent assignments for the course in full; – the presentation is not fluent; – answers to questions on the course are vague and confused; – the written work on the course is not carefully prepared. **d) A grade of "2" (unsatisfactory) may be given in the following cases:** – the student has not prepared for classes on the course; – the student has no understanding of the content of the classes; – the independent assignments for the course have not been completed in full; – there are signs that written work has been copied from others; – the written work contains serious errors and inaccuracies; – no answers are given to questions on the course, i.e. the student does not know the course.
Examination requirements	To earn the credits, the student must have fully mastered the theoretical and methodological concepts of the course, be able to present the results of analysis correctly, reason independently about the processes studied, complete the tasks and assignments given for assessment, and submit written work for the final assessment. Students who do not submit current assessment, midterm assessment and independent study assignments, or who score fewer than 30 points for these assignments and assessment components, are not admitted to the final assessment. Furthermore, a student who, without a valid reason, misses 25 percent or more of the contact hours allocated to the course will be withdrawn from the course, will not be admitted to the final examination, and will be considered not to have earned the relevant credits for the course. A student who fails the final examination or receives a score in the range of "0–29.9" for this examination is considered to have an academic debt.
Recommended literature	**Main literature:** 1. Safarov U.T., Yusupov A.H. Chorvachilik va oziq-ovqat mahsulotlarini sovutish uskuna va jihozlari hamda sovuqlik bilan ishlov berish texnologiyasi [Refrigeration Equipment and Cold Processing Technology for Livestock and Food Products]. Study guide. – Samarkand/Tashkent, 2023. – 236 p. 2. Karimov Q.F., Nurmatov T.B. Sovutish asoslari [Fundamentals of Refrigeration]. Study guide. – 2024. – 176 p. 3. Azizov D., Saydiev F. Sovutish texnikasi va sovutish tizimiga xizmat ko'rsatish asoslari [Refrigeration Engineering and Fundamentals of Refrigeration System Servicing]. Study guide. – Tashkent: Baktria press, 2017. – 176 p. 4. Ismanxodjaeva M.R., Nurmanov S.R. Sovuqlik bilan ta'minlash [Refrigeration Supply]. – Tashkent, 2023. – 136 p. **Additional literature:** 5. Mansurova Sh.P. Ventilyatsiya va havoni konditsiyalash tizimlari [Ventilation and Air-Conditioning Systems]. Textbook. – Jizzakh: So'g'diyona nashriyot matbaa uyi, 2023. – 153 p. 6. Nurmanov S.R., Usmonov Sh.A., Pirnazarov I.I. Ventilyatsiya va havoni konditsiyalash tizimlari [Ventilation and Air-Conditioning Systems]. Study guide. – Tashkent: Ijod-Press, 2019. – 512 p. 7. Ismanxodjaeva M.R. Ventilyatsiya va havoni konditsiyalash tizimlari [Ventilation and Air-Conditioning Systems]. Study guide. –

Tashkent: Ijod-Press, 2022. – 315 p.
8. Rashidov Yu.K. Issiqlik, gaz ta'minoti va ventilyatsiya [Heat and Gas Supply and Ventilation]. Textbook. – Tashkent: Cho'lpon, 2010. – 143 p.
9. QMQ 2.04.05-97*. Isitish, ventilyatsiya va konditsiyalash [Heating, Ventilation and Air Conditioning]. State Committee for Architecture and Construction of the Republic of Uzbekistan. – Tashkent, 2011.

Internet resources

10. www.gov.uz – Government portal of the Republic of Uzbekistan.
11. www.lex.uz – National database of legislation of the Republic of Uzbekistan.
12. www.mc.uz
13. www.ziyonet.uz – Information and educational network of the Republic of Uzbekistan.
14. www.setkov-psk.perm.ru