Course title	Heat Engineering (ECTS 6)
Subject/module code	IT3506
Semester(s) in which the course is taught	5th semester (2026–2027 academic year)
Assigned instructor	Tursunov M., associate professor, Department of Engineering Communications
Language of instruction	Uzbek
Course type	Compulsory
Study workload (including independent study)	**Total workload – 180 hours** **Contact hours – 72** Lecture hours – 48 Laboratory hours – none Practical class hours – 24 **Independent study – 108 hours** Course project – none
ECTS	6
Course aims and objectives / learning outcomes	**The aim of the course is to give students studying in the agricultural field at higher education institutions an understanding of the course "Heat Engineering", of the selection of thermal equipment and of the role of the course in industry.** **The objective of the course is to teach students how to improve thermal engineering equipment from the standpoint of energy efficiency in line with modern requirements, to justify its use for various purposes, to increase its efficiency while preserving its technical properties, and to gain skills and experience in ensuring energy-saving technologies in production.** **Prerequisites: (YK2304) Introduction to the Field of Study; (MMTX2304) Structure and Properties of Engineering Materials.** **Learning outcomes:** **Professional competencies:** 1. Analyses the basic concepts, laws and thermodynamic processes of heat engineering. 2. Is able to identify the types of heat transfer processes and the laws governing them. 3. Analyses the operating principles of heat engines, heat exchange devices and energy systems. 4. Is able to calculate the main thermodynamic and thermal engineering parameters of heat engineering installations. **Skills:** 5. Performs quality control. 6. Ensures production safety.
Course content (topics)	**I. Main theoretical section (Lectures) – 48 hours** **Topic 1: Introduction to the course "Heat Engineering". General information on technical thermodynamics. (2 hours)** The role and importance of the course "Heat Engineering". Methods of using heat energy. The role of heat energy in industry and everyday life. [2, 5] **Topic 2: Properties of ideal and real gases. Structure of gases. Forces of interaction between gas molecules. (2 hours)** The concepts of ideal and real gases. Forces of interaction between real gas molecules. Volume of a real gas, constant temperature. [1, 3] **Topic 3: Heat capacity. Internal energy. (2 hours)** Work done by a body during expansion and contraction under the action of energy. [3, 4] **Topic 4: Thermodynamic processes of ideal gases. Isochoric, isobaric and isothermal processes. (2 hours)** Operating principle of refrigerating machines. Types of refrigerating machines. Refrigerants. The role of the Carnot cycle in the refrigeration

process. [2, 5]

Topic 5: The first law of thermodynamics. Enthalpy and entropy. (2 hours)

The law of conservation and transformation of energy. Analytical expression of the first law of thermodynamics. Internal energy. Enthalpy and entropy. Work of expansion. Reversible and irreversible processes. The concept of a cycle.

Topic 6: The second law of thermodynamics. The direct Carnot cycle. (2 hours)

The essence of the second law of thermodynamics. The research of Sadi Carnot. Requirements for converting heat energy into mechanical work. [1, 4]

Topic 7: Internal combustion engines. (2 hours)

History of the internal combustion engine. Operating principle of an internal combustion engine. The four strokes, mechanisms, systems and cycles; types of internal combustion engines; transport. [3, 5]

Topic 8: Water vapour and moist air. (2 hours)

Operating principle of water heating systems. Operating principle of steam heating systems. Their differences and efficiency indicators. [3, 4]

Topic 9: Laws of heat exchange. (2 hours)

One body exchanges heat with another; the quality of energy affects a body; energy can act on one or several bodies at the same time; energy propagates in space. [2, 4]

Topic 10: Heat conduction in materials. (2 hours)

Heat conduction in single-layer and multilayer materials. Heat conduction in cylindrical and spherical materials. [1, 4]

Topic 11: Convective heat exchange. (2 hours)

Heat transfer in free motion. Newton's law. The Nusselt, Reynolds, Prandtl and Grashof numbers. [2, 5]

Topic 12: Radiative heat exchange. (2 hours)

The Stefan–Boltzmann law. Luminous intensity. The absolute black body. Concepts of absorption, reflection and transmission of heat energy. [1, 3]

Topic 13: Complex heat exchange. (2 hours)

Complex heat exchange. Heat transfer between two fluids separated by a wall.

Topic 14: Heat exchangers. Modern regenerative and recuperative equipment. (2 hours)

Thermal resistance to heat transfer. Regenerative and recuperative equipment. Heat transfer enhancement. [2, 3]

Topic 15: Introduction to convective heat transfer. (2 hours)**

Convective heat transfer. The Reynolds analogy. Combined conduction and convection. Dimensionless numbers and analysis of results. [1, 4]

Topic 16: Types of fuel. Types of fuel combustion. (2 hours)

General concepts of the fuels used in thermal equipment. Types of fuel combustion and the necessary conditions. Standard (reference) fuel. Types of furnaces. Use of liquid, solid and gaseous fuels. [1, 3]

Topic 17: Hot water and steam boilers. Steam turbines. (2 hours)

Theoretical cycle of a steam power plant. High-capacity heat-generating energy sources. Steam turbine plants. [4, 5]

Topic 18: Modern installations operating on secondary energy resources. (2 hours)

Main methods of organising energy-saving technologies. Improving the efficiency of using fuel and energy resources. General concepts of the fuels used in thermal equipment. [2, 4]

Topic 19: Calculation of heating pipelines. (2 hours)

Hydraulic calculation of horizontal and vertical heating systems. [1,

4]

Topic 20: The essence of Fourier's law. Thermal conductivity. (2 hours)**

The amount of heat passing through single-layer and multilayer flat walls. The Newton–Richmann law. The heat transfer coefficient. [2, 3]

Topic 21: Gas supply. (2 hours)

Calculation of medium- and low-pressure gas networks. [1, 3]

Topic 22: Air exchange systems. (2 hours)

Exhaust air exchange systems. Supply air exchange systems. Axial air exchange systems. [2, 4]

Topic 23: District heating. (2 hours)

Water heat networks, steam heat networks, hot water system. [1, 4]

Topic 24: Use of wind energy, hydropower and geyser energy. Bioenergy. (2 hours)

Wind generators. Wave energy. Biomass. Bioreactors for producing biogas. Study of biogas composition. [1, 5]

** Topics developed on the basis of the curricula of universities ranked in the TOP-300 of the QS and THE rankings: Delft University of Technology (TU Delft, QS – 49), course "Fluid Flow, Heat & Mass Transfer". Topic 15 – introduction to convective heat transfer; Topic 20 – Fourier's law, thermal conductivity, heat flow through single-layer and multilayer flat walls, the Newton–Richmann law and the heat transfer coefficient.

II. Guidelines and recommendations for practical classes – 24 hours

Practical classes consolidate the theoretical material of the lectures and develop students' skills in solving problems of technical thermodynamics, heat transfer and fuel combustion.

Recommended practical topics (2 hours each):

1. Studying and using the International System of Units (SI).
2. Studying and using thermodynamic parameters.
3. Solving problems using the Clapeyron equation.
4. Solving problems using the Mendeleev–Clapeyron equation.
5. Solving problems using Fourier's law and equation.
6. Solving problems using the Newton–Richmann law and equation.
7. Studying schemes for the use of renewable energy sources.
8. Solving problems on heat conduction.
9. Solving problems on convective heat exchange.
10. Solving problems on the Stefan–Boltzmann law.
11. Properties of fuels. Problems on fuels.
12. Solving problems on the performance of internal combustion engines.

III. Laboratory classes

Laboratory classes are not provided for in the curriculum of this course.

IV. Independent study – 108 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:

1. The theoretical founders of heat engineering. The period of development of heat engines. Trends in the use of renewable energy sources. (7 hours)

2. State parameters. Types of working media. Changes in the state of a working medium. The equation of state; the relationship between thermal parameters. (7 hours)

	3. The thermodynamic system. Heat capacity. Quantity of heat. Transfer of energy as heat. Work done. Operating principle of heat engines. (7 hours) 4. The heat source. Transfer of heat to the working medium. Determining the efficiency of heat exchangers. (7 hours) 5. Convective heat exchange. Heat transfer from solid bodies to the surroundings. Thermal conductivity. Temperature difference. Heat transfer. Calculating the amount of heat passing through single-layer and multilayer flat and cylindrical surfaces. (7 hours) 6. Heat exchangers. Regenerative and recuperative equipment. Plate heat exchangers. Heat and mass transfer. Convection. Thermal insulation. Selecting thermal insulation for pipes. (7 hours) 7. Radiation. Radiative heat exchange. Emissivity coefficients. Radiation. The Stefan–Boltzmann and Planck laws. Nuclear fuels. Nuclear power plants. (6 hours) 8. Condensation. Formation of condensate. Heat balance. Thermal equilibrium. Steam turbine plants. Gas turbine plants. Operating principle of thermal power plants. States of steam. The Rankine cycle. (6 hours) 9. Methods of heat treatment of building materials, products and structures. Thermal changes in materials under the action of heat. (6 hours) 10. Technical equipment for firing (calcination) and heating processes. The lime industry. Production of cement clinker; the cement clinker industry. (6 hours) 11. Types of fuel. Conditions and efficiency of fuel combustion. (6 hours) 12. Internal and external combustion engines. Jet and turbine engines. (6 hours) 13. Water and steam heating systems. (6 hours) 14. Heat exchangers. Modern regenerative and recuperative equipment. (6 hours) 15. Types of renewable energy sources. Design of panels and collectors. (6 hours) 16. Heat treatment of building materials, products and structures. (6 hours) 17. Convection. Types of convection. (6 hours) **V. Teaching technologies and methods** – lectures; – interactive case studies; – seminars (logical thinking, rapid question-and-answer sessions); – group work; – presentations; – individual projects.
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 “Heat Engineering” 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 in the current and midterm assessment, and submit the final assessment assignment. 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. Tursunov M.K. Ventilyatsiya va havoni konditsiyalash tizimlari

[Ventilation and Air-Conditioning Systems]. Textbook. – Jizzakh, 2025. – 260 p.

2. Toshmatov N.U. Issiqlik va gaz ta’minoti tizimlari [Heat and Gas Supply Systems]. Textbook. – Tashkent, 2021. – 94 p.

3. Musayev Sh.M. Issiqlik ishlab chiqarish uskunalari [Heat Generation Equipment]. Study guide for students of higher education institutions. – Tashkent: Lesson Press, 2021. – 158 p.

4. Tursunov M. Issiqlik ta’minoti tizimlari [Heat Supply Systems]. Study guide. – 2023. – 122 p.

5. Meliyev B., Musayev Sh. Issiqlik va gaz ta’minoti [Heat and Gas Supply]. Study guide. – 2021. – 123 p.

Additional literature:

6. Nurmatov J., Xalilov N.A., Tolipov U.K. Issiqlik texnikasi [Heat Engineering]. Study guide. – Tashkent: O‘qituvchi, 1998. – 35 p.

7. Madaliyev E.O‘. Issiqlik texnikasi [Heat Engineering]. Textbook for higher education institutions. – Fergana: Farg‘ona, 2001. – 32 p.

8. Zohidov R.A., Alimova M.M., Mavjudova Sh.S. Issiqlik texnikasi [Heat Engineering]. Textbook. – Tashkent: O‘zbekiston faylasuflari milliy jamiyati, 2010. – 40 p.

9. Xudoyberdiyev T.S., Shaymardanov B.P., Usmonov K.E. Issiqlik texnikasi fanidan masalalar to‘plami [Collection of Problems in Heat Engineering]. Study guide. – Tashkent: TIIAME, 2015. – 46 p.

10. Луканин В.Н., Шатров М.Г., Камфер Г.М. и др. Теплотехника [Lukanin V.N., Shatrov M.G., Kamfer G.M. et al. Heat Engineering]. Textbook for universities / ed. V.N. Lukanin. 2nd ed., revised. – Moscow: Vysshaya shkola, 2000. – 37 p.

Internet resources

11. www.gov.uz – Government portal of the Republic of Uzbekistan.

12. www.lex.uz – National database of legislation of the Republic of Uzbekistan.

13. www.ziyonet.uz – Information and educational network of the Republic of Uzbekistan.

14. http://www.GES.ru

15. http://www.nasos.ru

16. http://www.energ.narod.ru