

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

**O. M. BEKETOV NATIONAL UNIVERSITY
of URBAN ECONOMY in KHARKIV**

METHODOLOGICAL RECOMMENDATIONS

for conducting practical classes and organizing independent work
in the academic discipline

**«QUALITY CONTROL IN THE CONSTRUCTION OF ENERGY-
EFFICIENT BUILDINGS»**

*(for applicants of the second (Master's) level of higher education in all forms of study
in the specialty 192 – Construction and Civil Engineering
field of knowledge 19 – Architecture and Construction,
educational programs “Urban Construction and Economy,” “Industrial and Civil
Construction,” “Civil Engineering”)*

**Kharkiv
O. M. Beketov NUUE
2025**

УДК 536.24:66.021.3(07)

Methodological recommendations for conducting practical classes and organizing independent work in the academic discipline «Quality Control in the Construction of Energy-Efficient Buildings» (for students of the second (Master's) level of higher education in all forms of study in the specialty 192 – Construction and Civil Engineering field of knowledge 19 – Architecture and Construction, educational programs “Urban Construction and Economy,” “Industrial and Civil Construction,” “Civil Engineering”) / O. M. Beketov National University of Urban Economy in Kharkiv ; comp. Y. O. Burda. – Kharkiv : O. M. Beketov NUUE, 2025. – 26 p.

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*Recommended by the Department of Heat and Gas Supply and Ventilation,
Protocol No 5 dated 12.12.2024*

The methodological recommendations are intended for students of the specialty 192 – Construction and Civil Engineering. They provide requirements for formatting, tools and sequence of task execution, a list of recommended sources and examples of work formatting.

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1 DESCRIPTION OF BUILDING DEFECTS DURING EXTERNAL AND INTERNAL INSPECTION

Purpose of the Lesson.

The purpose of this lesson is to develop the skills necessary to identify, describe, and document defects in building structures through systematic external and internal inspections. This knowledge is critical for assessing structural integrity, energy performance, and safety, as well as for planning repair, retrofitting, or energy-efficiency improvements. Students will learn to recognize the signs of material degradation, construction deficiencies, and improper maintenance, forming a basis for professional evaluation and decision-making in both new and existing buildings.

Theoretical Provisions.

Building defects arise from a combination of factors including material deterioration, design errors, construction deficiencies, environmental impact, and inadequate maintenance. External defects commonly include cracks in walls, moisture penetration, façade deformation, roof damage, and deterioration of insulation materials. Internal defects often manifest as wall cracks, mold formation, condensation, uneven floors, water leakage, and mechanical failures of building systems. Effective defect identification requires understanding the interaction between structural elements, environmental conditions, and building materials. Inspection methods are guided by regulatory standards, building codes, and international best practices, emphasizing systematic observation, measurement, and documentation. Proper classification and description of defects allow engineers to prioritize interventions, prevent further deterioration, and ensure compliance with energy efficiency and safety standards.

Systematic inspection begins with external observation, including the evaluation of walls, roofs, windows, doors, and insulation. Indicators such as cracks, discoloration, deformation, moisture stains, and material separation are noted. Internal inspection involves assessing walls, ceilings, floors, and service systems for defects that may not be visible externally. The process includes detecting signs of moisture accumulation, mold growth, thermal bridging, and mechanical wear.

Documentation should include photographs, sketches, and detailed descriptions to support maintenance planning, risk assessment, and potential retrofitting measures.

Inspection results provide insight into both structural performance and energy efficiency. For instance, moisture ingress can compromise thermal insulation and lead to increased energy consumption, while visible cracks may indicate underlying structural stress affecting overall building stability. In the European Union, inspections are often performed by certified building surveyors following harmonized standards, whereas in Ukraine, inspections are conducted by qualified engineers with increasing adoption of EU-inspired methodologies. Consistent and accurate defect reporting enables informed decisions regarding repair, renovation, and energy-efficient improvements, ensuring the safety, durability, and sustainability of buildings.

PRACTICAL WORK TASK TOPIC 1

Theoretical questions

1. What are the main factors that contribute to the formation of defects in building structures?
2. How do external and internal building defects differ in terms of causes and observable signs?
3. Why is systematic inspection and documentation of defects important for energy efficiency and structural safety?
4. What methods are commonly used to detect and classify defects during building inspections?
5. How do inspection practices in the European Union differ from those in Ukraine regarding defect identification and reporting?

2 ANALYSIS OF DEFECTS DURING THERMAL MODERNIZATION

Purpose of the Lesson.

The purpose of this lesson is to understand the methods of identifying and analyzing defects that occur during the thermal modernization of buildings. Thermal modernization involves improving the thermal performance of building envelopes and engineering systems to enhance energy efficiency, reduce operational costs, and ensure occupant comfort. Understanding potential defects allows engineers and construction specialists to prevent energy losses, structural damage, and ensure compliance with modern energy standards.

Theoretical Provisions.

Thermal modernization typically includes insulation of walls, roofs, floors, replacement of windows and doors, and upgrading heating, ventilation, and cooling systems. Defects in this process can arise from poor material selection, incorrect installation, inadequate design, or lack of quality control. Common defects include thermal bridges, insufficient insulation thickness, gaps between insulation layers, improper sealing of joints, moisture accumulation, and degradation of materials due to environmental factors. These defects can significantly reduce the effectiveness of energy-saving measures and may lead to mold growth, condensation, or structural deterioration.

Analysis of defects requires a systematic approach combining visual inspection, measurement, and diagnostic techniques. External walls, roofs, and floors are examined for irregularities, gaps, cracks, or signs of moisture ingress. Thermographic imaging is often employed to detect areas of heat loss or thermal bridges. Internal inspection focuses on areas where moisture, mold, or condensation might appear, as well as checking the proper integration of insulation with building services. In the European Union, standardized methods for defect analysis are widely applied, often including performance verification, energy audits, and documentation according to regulatory frameworks. In Ukraine, practices are evolving, with increased adoption of

EU-inspired approaches and greater emphasis on detailed defect reporting and corrective actions.

Effective defect analysis ensures that thermal modernization achieves its intended objectives. It supports decision-making regarding repairs, retrofitting, or adjustments to insulation and engineering systems. Moreover, systematic identification and correction of defects improve energy efficiency, enhance building durability, and maintain occupant health and comfort.

PRACTICAL WORK TASK TOPIC 2

Theoretical questions

1. What are the most common types of defects that occur during thermal modernization of buildings?
2. How can thermal bridges and gaps in insulation affect the overall energy efficiency of a building?
3. What diagnostic techniques are used to detect defects in walls, roofs, and floors during thermal modernization?
4. How does defect analysis differ between practices in the European Union and Ukraine?
5. Why is systematic documentation and correction of defects essential for achieving the objectives of thermal modernization?

3 ANALYSIS OF THERMOGRAPHIC IMAGING

Purpose of the Lesson.

The purpose of this lesson is to develop the skills necessary to interpret and analyze thermographic images for assessing the thermal performance of buildings. Thermographic imaging is a non-destructive diagnostic tool that allows engineers, architects, and energy specialists to identify heat losses, thermal bridges, moisture intrusion, and insulation deficiencies. Mastering thermographic analysis enables

professionals to make informed decisions regarding energy efficiency improvements, defect correction, and building retrofitting.

Theoretical Provisions.

Thermographic imaging, or infrared thermography, detects infrared radiation emitted from surfaces and translates it into visual images representing temperature distribution. In buildings, it reveals areas of heat loss, inadequate insulation, air leakage, thermal bridging, and moisture-related problems. Proper interpretation of thermographic data requires understanding environmental conditions, material properties, and the context of the building envelope. For example, sun exposure, wind, and ambient temperature can affect readings, making controlled conditions essential for accurate assessment.

Analysis begins by capturing high-resolution thermographic images of external and internal surfaces. External inspections focus on walls, roofs, windows, doors, and façades to detect heat loss patterns. Internal inspections target walls, ceilings, floors, and service installations to identify cold spots, condensation risks, and poorly insulated areas. European Union standards often require thermographic surveys to be conducted under specific climatic and operational conditions, ensuring that energy performance assessments are accurate and reliable. In Ukraine, thermography is increasingly applied for energy audits, defect detection, and verification of retrofitting works, though practices may vary in rigor depending on project scale and expertise.

Interpretation of thermographic images involves identifying temperature gradients, color-coded anomalies, and irregularities that indicate potential defects or inefficiencies. Thermal bridges, gaps in insulation, moisture infiltration, and equipment malfunctions can all be detected and documented for corrective action. Integration of thermographic analysis with other diagnostic methods, such as moisture measurements, visual inspections, and energy modeling, enhances the accuracy and reliability of conclusions. Proper analysis supports energy-efficient design, renovation decisions, and verification of compliance with energy performance standards.

In conclusion, thermographic imaging is an essential tool in modern building diagnostics. It enables precise detection of energy inefficiencies, structural and insulation defects, and moisture problems. Comparing European Union and Ukrainian practices shows that while the EU applies standardized, regulated procedures for thermography, Ukraine is progressively adopting similar approaches, emphasizing systematic analysis, documentation, and corrective measures to achieve energy efficiency, occupant comfort, and building durability.

PRACTICAL WORK TASK TOPIC 3

Theoretical questions

1. What physical principle underlies thermographic imaging, and how does it detect heat loss in buildings?
2. How can environmental factors such as wind, sun exposure, and ambient temperature affect thermographic measurements?
3. What types of building defects and inefficiencies can be identified using thermographic analysis?
4. How do thermographic inspection practices differ between the European Union and Ukraine?
5. Why is it important to combine thermographic imaging with other diagnostic methods for accurate assessment of building performance?

4 ANALYSIS OF DESIGN SOLUTIONS FOR BUILDING INSULATION

Purpose of the Lesson.

The purpose of this lesson is to develop the ability to critically analyze and evaluate design solutions related to the insulation of buildings. This includes assessing materials, construction techniques, and design configurations to ensure optimal thermal performance, energy efficiency, and compliance with regulatory standards. Mastery of this topic enables students to identify potential weaknesses in

design, propose improvements, and ensure that insulation strategies contribute effectively to energy savings and occupant comfort.

Theoretical Provisions.

Design solutions for building insulation encompass material selection, placement strategies, thermal resistance calculations, and integration with architectural and structural elements. Proper insulation reduces heat loss through walls, roofs, floors, and foundations, preventing thermal bridging and moisture accumulation. Effective insulation design considers local climate conditions, building orientation, occupancy patterns, and energy performance requirements. In the European Union, insulation design is closely guided by harmonized standards and nearly zero-energy building regulations, which require careful consideration of material properties, thickness, and continuity of the thermal envelope. Computational modeling and simulations are often employed to predict thermal behavior, optimize insulation placement, and evaluate potential energy savings.

In Ukraine, insulation design practices are evolving to align with EU standards. Traditional approaches focused primarily on prescriptive insulation thicknesses and material types, without detailed modeling of thermal performance. Modern practices now incorporate energy calculations, consideration of thermal bridges, and integration of insulation with ventilation, heating, and cooling systems. Evaluation of design solutions involves reviewing architectural drawings, construction details, and material specifications to identify potential points of heat loss or moisture ingress. Design analysis also includes consideration of durability, fire safety, cost-effectiveness, and ease of installation.

Critical analysis of insulation design allows engineers to detect potential weaknesses, such as insufficient material thickness, gaps in insulation layers, poorly detailed junctions, or incompatible materials that may compromise thermal performance. Comparing EU and Ukrainian practices demonstrates the importance of thorough design review, simulation-based validation, and quality assurance measures. Properly analyzed and executed insulation strategies enhance energy efficiency,

reduce operational costs, improve indoor comfort, and contribute to the long-term sustainability of buildings.

PRACTICAL WORK TASK TOPIC 4

Theoretical questions

1. What are the key factors to consider when analyzing building insulation design solutions for energy efficiency?
2. How do thermal bridges and material selection influence the effectiveness of building insulation?
3. What methods are used in the European Union to evaluate and validate insulation design solutions?
4. How have insulation design practices in Ukraine evolved to align with EU standards and energy efficiency requirements?
5. Why is it important to assess insulation design in conjunction with ventilation, heating, and cooling systems?

5 ANALYSIS OF DAMAGE IN ENGINEERING SYSTEMS: HEATING, VENTILATION, AND ELECTRICAL SUPPLY

Purpose of the Lesson.

The purpose of this lesson is to provide students with the knowledge and skills necessary to identify, analyze, and document damage in critical engineering systems, including heating, ventilation, and electrical supply. Understanding the types and causes of damage is essential for maintaining system efficiency, ensuring occupant comfort and safety, and planning repair or modernization measures. This analysis is a key step in improving energy efficiency and prolonging the operational lifespan of building systems.

Theoretical Provisions.

Engineering systems are subject to various forms of damage due to material degradation, design deficiencies, operational errors, environmental factors, and inadequate maintenance. In heating systems, damage may manifest as leaks,

corrosion in pipes, faulty valves, pump failures, or uneven temperature distribution. Ventilation systems can experience blockages, mechanical failures of fans, duct leakage, contamination of air pathways, or malfunctioning control units. Electrical supply systems may suffer from insulation breakdown, loose connections, overloads, short circuits, or damage to distribution boards and protective devices.

The analysis of damage involves both visual inspection and technical diagnostics. Heating systems are examined for leaks, signs of corrosion, pressure inconsistencies, and malfunctioning control devices. Ventilation systems are checked for airflow irregularities, fan operation, duct integrity, and proper functioning of heat recovery units. Electrical systems require inspection of circuit continuity, grounding effectiveness, protective device operation, and overall compliance with safety standards. Advanced diagnostic tools such as thermal imaging, ultrasonic leak detectors, and electrical testing instruments are widely used to detect hidden or non-obvious defects.

In the European Union, systematic procedures for analyzing engineering system damage are standardized and integrated into energy efficiency and building maintenance regulations. Regular inspections, monitoring, and preventive maintenance are emphasized, with detailed reporting and verification processes. In Ukraine, while inspections have traditionally focused on compliance with building codes and safety requirements, modern practices are increasingly incorporating EU-inspired approaches, including energy audits, condition monitoring, and performance-based evaluations.

Accurate identification and analysis of damage allow engineers to plan timely repairs, prevent further deterioration, optimize energy efficiency, and maintain the safety and reliability of building operations. It also informs modernization strategies, such as retrofitting heating systems with high-efficiency equipment, upgrading ventilation controls, or improving electrical distribution networks, which are essential for achieving sustainable and energy-efficient buildings..

PRACTICAL WORK TASK TOPIC 5

Theoretical questions

1. What are the common types of damage observed in heating, ventilation, and electrical supply systems?
2. How do environmental factors and operational errors contribute to damage in engineering systems?
3. What diagnostic tools and methods are used to detect hidden or non-obvious defects in building systems?
4. How do damage analysis and maintenance practices differ between the European Union and Ukraine?
5. Why is timely identification and correction of damage critical for energy efficiency, safety, and the longevity of engineering systems?

6 IDENTIFICATION OF KEY ASPECTS OF ENERGY-EFFICIENT CONSTRUCTION

Purpose of the Lesson.

The purpose of this lesson is to identify and understand the fundamental aspects that define energy-efficient construction practices in Ukraine. This includes examining regulatory frameworks, design strategies, material selection, and technological innovations that contribute to reducing energy consumption, improving indoor environmental quality, and ensuring sustainability. Mastery of this topic enables professionals to evaluate current construction practices and implement effective measures to align Ukrainian buildings with modern energy efficiency standards.

Theoretical Provisions.

Energy-efficient construction aims to minimize energy consumption while maintaining comfort, safety, and durability. In Ukraine, this approach has evolved gradually, driven by both national regulations and the adoption of European Union-inspired standards. Key aspects include the thermal performance of building

envelopes, efficient heating, ventilation, and cooling systems, and integration of renewable energy sources. Proper insulation of walls, roofs, floors, and foundations is essential to reduce heat loss and maintain stable indoor temperatures, while high-performance windows and doors prevent energy waste.

Engineering systems in energy-efficient buildings are designed for optimal performance, using high-efficiency boilers, heat pumps, ventilation units with heat recovery, and energy-efficient lighting and electrical equipment. Intelligent control and automation systems are increasingly applied to monitor energy consumption, adjust heating or cooling loads dynamically, and ensure occupant comfort. Material selection plays a significant role, with preference given to durable, low-thermal-conductivity materials that also comply with fire safety and environmental standards.

Regulatory and policy aspects are crucial in shaping energy-efficient construction in Ukraine. National building codes, energy performance requirements, and incentives for energy-efficient technologies guide the planning, design, and execution of construction projects. Continuous monitoring, inspection, and verification procedures are implemented to ensure compliance and identify opportunities for further energy savings. The alignment with EU directives, including nearly zero-energy building requirements, is progressively influencing Ukrainian practice, promoting sustainable development and energy independence.

Finally, energy-efficient construction also emphasizes occupant health and comfort. Properly designed thermal envelopes, ventilation systems, and indoor environmental control maintain optimal temperatures, humidity, and air quality while minimizing energy use. The combination of regulatory frameworks, technological solutions, and practical construction techniques defines the key aspects of energy-efficient construction in Ukraine, aiming to achieve sustainable, safe, and comfortable buildings that reduce operational costs and environmental impact.

PRACTICAL WORK TASK TOPIC 6

Theoretical questions

1. What are the main principles that define energy-efficient construction practices in Ukraine?
2. How do building envelope characteristics, such as insulation and window performance, impact energy efficiency?
3. What role do engineering systems, including heating, ventilation, and cooling, play in achieving energy efficiency in Ukrainian buildings?
4. How do national regulations and EU-inspired directives influence energy-efficient construction practices in Ukraine?
5. Why is the integration of renewable energy sources and intelligent control systems important in modern energy-efficient buildings?

7 ANALYSIS OF THE EFFICIENCY OF SOLAR HEATING AND DOMESTIC HOT WATER SYSTEMS IN ENERGY-EFFICIENT BUILDINGS

Purpose of the Lesson.

The purpose of this lesson is to provide students with knowledge and skills to evaluate the efficiency of solar heating and domestic hot water systems in energy-efficient buildings. Understanding how solar systems function, how to assess their performance, and how they integrate with other building energy systems is essential for reducing energy consumption, lowering operational costs, and achieving sustainable and environmentally friendly building operation.

Theoretical Provisions.

Solar heating and domestic hot water systems harness solar energy to provide space heating and hot water, reducing reliance on conventional energy sources. Their efficiency depends on proper system design, selection of solar collectors, storage tanks, circulation systems, and integration with existing heating infrastructure. Energy-efficient buildings often incorporate solar systems as part of an overall

strategy to achieve low energy consumption, improve indoor comfort, and meet regulatory standards.

Performance analysis involves assessing solar radiation availability, system sizing, collector orientation, tilt angles, and thermal losses in storage and distribution. In the European Union, standardized procedures for evaluating solar system efficiency include monitoring system performance under actual operating conditions, using temperature sensors, flow meters, and energy meters, and comparing collected energy with theoretical predictions. In Ukraine, adoption of similar practices is emerging, with increasing use of monitoring and data analysis to verify system performance and optimize operation.

Integration with building heating and hot water systems is critical to ensure energy is effectively utilized without overheating or excessive reliance on backup energy sources. Proper control strategies, such as differential temperature control, ensure solar energy is maximized while maintaining occupant comfort. Documentation and analysis of system efficiency support future design improvements, regulatory compliance, and planning for maintenance or retrofitting.

Efficient solar heating and domestic hot water systems contribute significantly to reducing energy consumption, minimizing greenhouse gas emissions, and achieving nearly zero-energy building standards. Understanding system design, monitoring, and performance analysis enables engineers to make informed decisions about material selection, system configuration, and energy management strategies.

PRACTICAL WORK TASK TOPIC 7

Theoretical questions

1. What factors determine the efficiency of solar heating and domestic hot water systems in energy-efficient buildings?
2. How does the orientation and tilt of solar collectors affect system performance?

3. What methods are used in the European Union to monitor and evaluate the efficiency of solar heating systems?
4. How is the integration of solar systems with building heating and hot water infrastructure managed to maximize energy efficiency?
5. Why is performance analysis and documentation important for optimizing solar heating and domestic hot water systems in energy-efficient buildings?

8 ANALYSIS OF THE EFFICIENCY OF HEAT RECOVERY VENTILATION SYSTEMS IN ENERGY-EFFICIENT BUILDINGS

Purpose of the Lesson.

The purpose of this lesson is to develop the knowledge and skills necessary to analyze and assess the efficiency of heat recovery ventilation (HRV) systems in energy-efficient buildings. HRV systems are critical for maintaining indoor air quality while minimizing energy losses. Understanding their operation, performance metrics, and integration with other building systems enables professionals to optimize energy efficiency, reduce operational costs, and ensure occupant comfort and health.

Theoretical Provisions.

Heat recovery ventilation systems work by transferring heat from outgoing stale air to incoming fresh air, reducing the need for additional heating or cooling. The efficiency of these systems depends on factors such as heat exchanger design, airflow balance, control strategies, and maintenance practices. Properly designed HRV systems help prevent heat loss, control humidity, and maintain a comfortable indoor environment, making them essential in energy-efficient buildings.

System performance analysis involves measuring airflow rates, temperature recovery efficiency, pressure drops, and the effectiveness of filters. Thermodynamic principles are applied to evaluate heat transfer and energy savings. In the European Union, HRV system efficiency is assessed using standardized procedures, including laboratory testing and on-site performance monitoring. Continuous monitoring and advanced control systems enable real-time optimization and early detection of defects

or imbalances. In Ukraine, adoption of HRV systems is increasing, with performance analysis practices gradually aligning with EU standards. Visual inspections, airflow measurements, and thermal monitoring are becoming standard methods for evaluating HRV performance.

Integration with other building systems is crucial for maximizing energy savings. HRV units are often linked with heating, cooling, and building automation systems to ensure synchronized operation and minimal energy consumption. Proper maintenance and filter replacement are critical to maintaining high efficiency and indoor air quality. Analysis of HRV systems also considers the impact of building envelope characteristics, occupancy patterns, and seasonal variations on overall system performance.

Overall, understanding and analyzing HRV system efficiency supports energy-efficient design, reduces operational costs, improves indoor comfort, and ensures compliance with energy performance standards. Comparing EU and Ukrainian practices highlights the importance of systematic evaluation, monitoring, and continuous improvement to achieve sustainable and efficient building operation.

PRACTICAL WORK TASK TOPIC 8

Theoretical questions

1. How do heat recovery ventilation (HRV) systems reduce energy losses in energy-efficient buildings?
2. What factors influence the efficiency of HRV systems, including airflow and heat exchanger design?
3. How are HRV system performance and efficiency evaluated in the European Union compared to Ukraine?
4. Why is integration of HRV systems with heating, cooling, and building automation systems important for overall energy efficiency?
5. What maintenance practices are critical for maintaining HRV system efficiency and indoor air quality?

9 ANALYSIS OF THE EFFICIENCY OF EXTERNAL AND INTERNAL LIGHTING SYSTEMS IN ENERGY-EFFICIENT BUILDINGS

Purpose of the Lesson.

The purpose of this lesson is to provide students with the knowledge and skills to analyze the efficiency of both external and internal lighting systems in energy-efficient buildings. Efficient lighting design reduces electricity consumption, improves visual comfort, and supports sustainability objectives. Understanding how lighting technologies, control systems, and design strategies influence energy performance is essential for achieving environmentally responsible and cost-effective building operation.

Theoretical Provisions.

Lighting efficiency in buildings is determined by the type of luminaires, light sources, placement, control systems, and integration with natural daylight. Energy-efficient buildings rely on high-performance LED lighting, dimmable systems, occupancy sensors, and automated daylight harvesting to minimize energy use while maintaining adequate illumination. External lighting, such as façades, pathways, and public spaces, must be designed to provide safety and visibility without excessive energy consumption or light pollution.

Performance analysis involves measuring energy consumption, illumination levels, uniformity, and system responsiveness. In the European Union, standardized procedures for evaluating lighting efficiency include on-site measurements, computer simulations, and adherence to EU energy performance standards. These procedures assess both operational energy use and lighting quality to ensure compliance with nearly zero-energy building requirements. In Ukraine, similar practices are emerging, with increasing adoption of LED systems, automated controls, and performance monitoring to improve energy efficiency.

Integration of lighting systems with building automation platforms allows real-time monitoring and dynamic adjustment of lighting levels according to occupancy and natural light availability. Proper design and evaluation prevent over-illumination, reduce electricity costs, and contribute to sustainable building operation. Energy-

efficient lighting also enhances occupant comfort, productivity, and overall building aesthetics. Analyzing lighting system efficiency provides valuable insights for selecting appropriate technologies, optimizing control strategies, and planning retrofits or new installations to achieve maximum energy savings and compliance with modern standards.

PRACTICAL WORK TASK TOPIC 9

Theoretical questions

1. What factors determine the energy efficiency of internal and external lighting systems in buildings?
2. How do LED technologies, automated controls, and daylight harvesting improve lighting efficiency?
3. How are lighting systems evaluated in the European Union compared to Ukraine in terms of energy performance and quality?
4. Why is integration of lighting systems with building automation platforms important for energy-efficient operation?
5. How does proper design and monitoring of lighting systems contribute to occupant comfort, safety, and sustainability?

10 ANALYSIS OF THE EFFICIENCY OF RAINWATER HARVESTING AND UTILIZATION SYSTEMS IN ENERGY-EFFICIENT BUILDINGS

The purpose of this lesson is to provide students with the knowledge and skills to analyze the efficiency of rainwater harvesting and utilization systems in energy-efficient buildings. These systems reduce reliance on municipal water supply, decrease operational costs, and contribute to sustainable building practices. Understanding the design, performance, and integration of rainwater systems enables professionals to optimize water management, enhance environmental sustainability, and support energy-efficient building operation.

Theoretical Provisions.

Rainwater harvesting involves collecting, storing, and utilizing rainwater from building roofs or other surfaces for non-potable purposes, such as irrigation, toilet flushing, and cooling systems. The efficiency of such systems depends on rainfall availability, collection surface area, storage capacity, filtration, and distribution infrastructure. Properly designed systems reduce water consumption, mitigate stormwater runoff, and integrate seamlessly with building services to maximize sustainability benefits.

Performance analysis requires assessing the volume of collected water, storage losses, system reliability, and end-use efficiency. In the European Union, standardized procedures for evaluating rainwater harvesting systems include monitoring water collection, storage, and distribution efficiency, as well as lifecycle assessments to ensure compliance with environmental and building regulations. In Ukraine, the adoption of rainwater harvesting is increasing, though practices vary; emerging projects are incorporating storage tanks, filtration systems, and automated distribution, guided by EU-inspired design standards.

Integration with other building systems, such as irrigation networks, greywater reuse, and cooling systems, enhances overall efficiency. Proper maintenance, including filter cleaning and tank inspection, ensures long-term performance and prevents contamination. Analyzing the efficiency of rainwater systems supports decision-making for retrofitting existing buildings, planning new constructions, and achieving sustainable water management goals. Overall, these systems contribute to energy-efficient building operation by reducing energy and water-related operational demands, supporting environmental stewardship, and improving resilience to water scarcity.

PRACTICAL WORK TASK TOPIC 10

Theoretical questions

1. What factors determine the efficiency of rainwater harvesting and utilization systems in buildings?
2. How does the integration of rainwater systems with other building services, such as irrigation or cooling, improve overall efficiency?
3. What methods are used in the European Union to evaluate the performance of rainwater harvesting systems?
4. How do Ukrainian practices for rainwater harvesting differ from those in the European Union, and how are they evolving?
5. Why is regular maintenance, including filtration and storage inspection, essential for the long-term efficiency of rainwater utilization systems?

11 QUALITY CONTROL OF INSTALLATION AND OPERATION OF SOLAR HEATING AND DOMESTIC HOT WATER SYSTEMS IN ENERGY-EFFICIENT BUILDINGS

Purpose of the Lesson.

The purpose of this lesson is to provide students with knowledge and practical skills to ensure quality control during the installation and operation of solar heating and domestic hot water systems in energy-efficient buildings. Proper quality control guarantees that these systems function efficiently, achieve the intended energy savings, and comply with safety and regulatory standards. Understanding quality control procedures enables professionals to identify potential errors, prevent system underperformance, and maintain long-term reliability and sustainability.

Theoretical Provisions.

Solar heating and domestic hot water systems are complex assemblies that include solar collectors, storage tanks, circulation pumps, heat exchangers, piping, and control devices. Quality control begins with verifying that all components meet design specifications, technical standards, and manufacturer recommendations. Installation procedures must ensure proper orientation and tilt of collectors, secure

mounting, correct piping connections, and effective thermal insulation. Faulty installation can lead to reduced efficiency, leaks, overheating, or premature equipment failure.

During operation, quality control involves monitoring system performance, checking temperature differentials, flow rates, and energy output, and ensuring proper functioning of control systems. In the European Union, quality control is highly standardized, with detailed commissioning procedures, performance verification, and documentation of compliance with energy efficiency regulations. In Ukraine, practices are developing to align with EU standards, increasingly including systematic testing, monitoring, and maintenance documentation. Inspections are conducted to detect leaks, pump failures, air entrainment in circulation loops, or malfunctioning sensors, which could compromise system efficiency.

Proper quality control ensures that solar heating and domestic hot water systems deliver maximum energy savings, reduce dependency on conventional energy sources, and provide reliable hot water supply. It also facilitates preventive maintenance, early detection of defects, and informed decision-making for system upgrades or retrofits. By applying rigorous quality control measures, engineers ensure that the sustainability and efficiency goals of energy-efficient buildings are fully realized.

PRACTICAL WORK TASK TOPIC 11

Theoretical questions

1. What are the critical aspects to verify during the installation of solar heating and domestic hot water systems to ensure quality and efficiency?
2. How can improper installation of solar collectors or piping affect system performance and reliability?
3. What performance indicators are monitored during the operation of solar heating systems to ensure proper functioning?

4. How do quality control procedures in the European Union differ from current practices in Ukraine?
5. Why is systematic monitoring, maintenance, and documentation essential for the long-term efficiency of solar heating and domestic hot water systems?

LIST OF RECOMMENDED SOURCES

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Електронне навчальне видання

Методичні рекомендації
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з навчальної дисципліни

**«КОНТРОЛЬ ЯКОСТІ У БУДІВНИЦТВІ ЕНЕРГОЕФЕКТИВНИХ
БУДІВЕЛЬ»**

*(для здобувачів другого (магістерського) рівня вищої освіти всіх форм
навчання зі спеціальності 192 – Будівництво та цивільна інженерія
галузі знань 19 – Архітектура та будівництво,
освітні програми «Міське будівництво та господарство», «Промислове і
цивільне будівництво», «Цивільна інженерія»)*

Укладач **БУРДА** Юрій Олександрович

Відповідальний за випуск *Ю. І. Чайка*
За авторською редакцією
Комп'ютерне верстання *Ю.О. Бурда*

План 2025, поз. 574М

Підп. до друку 01.09.2025. Формат 60 × 84/16.
Ум. друк. арк. 1,5.

Видавець і виготовлювач:
Харківський національний університет
міського господарства імені О. М. Бекетова,
вул. Чорноглазівська (Маршала Бажанова), 17, Харків, 61002.
Електронна адреса: office@kname.edu.ua
Свідоцтво суб'єкта видавничої справи:
ДК № 5328 від 11.04.2017.