Syllabus
Course Program

Basics of thermography

Specialty
141 – Electric Power Engineering, Electrical Engineering and Electromechanics

Institute
Institute of Education and Science in Power Engineering, Electronics and Electromechanics

Educational program
Electrical Power Engineering. Electric Power Stations,
Electrical Power Engineering. Energy Management and Energy-Efficient Technologies

Department
Electric Power Stations (130)

Level of education
Bachelor's level.

Course type
Special (professional), Optional

Semester
6

Language of instruction
English, Ukrainian

Lecturers and course developers

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Assistant

Author of more than 20 scientific publications and educational and methodological works. Leading lecturer in the disciplines: "Fundamentals of thermography", "Energy management and audit", "Renewable energy sources and secondary energy resources"
More about the lecturer on the department's website

General information

Summary

The discipline "Fundamentals of thermography" provides students with fundamental knowledge and practical skills in the field of thermographic examination. Applicants will get acquainted with the principles of operation of thermal imagers, the basics of thermal processes and their application in various industries.
The course covers theoretical material on the physical basis of thermography, including an understanding of infrared radiation and the thermal properties of materials. Students will gain practical skills in using thermal imagers, processing thermographic images and interpreting the received data.

Course objectives and goals

Study of the physical foundations of the principle of operation of electronic-optical devices for measuring thermal radiation and its comparison with the temperature of surfaces; study of methods of using thermal imagers in the field of thermographic analysis of construction objects, electrical engineering, mechanics and other fields.; acquiring the skills of correct interpretation and analysis of thermal images (thermograms).
Learning outcomes.

Know:
– Physical foundations of thermography, including principles of infrared radiation and thermal properties of materials.
- Principles of operation and structure of thermal imagers, their functionality and limitations.

Be able:
– Use thermal imagers to obtain thermographic images.
– Process and analyze thermographic images.
– Identify thermal anomalies and determine the technical condition of objects using thermography.

Format of classes

Lectures, practical classes, independent work, consultations. Final control - credit.

Competencies

K06. Ability to identify, pose and solve problems.
K14. The ability to solve complex specialized tasks and practical problems related to problems of metrology, electrical measurements, the operation of automatic control devices, relay protection and automation.
K19. Awareness of the need to increase the efficiency of electric power, electrotechnical and electromechanical equipment.
K28. Obtaining and using professional knowledge and understanding related to conducting an energy audit, developing and implementing energy-saving measures and increasing the energy efficiency of various facilities and energy management systems.

Learning outcomes

PR02. To know and understand the theoretical foundations of metrology and electrical measurements, the principles of operation of automatic control devices, relay protection and automation, to have the skills to perform appropriate measurements and use these devices to solve professional tasks.
PR07. To carry out the analysis of processes in electric power, electrotechnical and electromechanical equipment, relevant complexes and systems.
PR09. To be able to evaluate the energy efficiency and reliability of electric power, electrotechnical and electromechanical systems.
PR27. Know and understand energy audit processes, development and implementation of energy saving and energy efficiency improvement measures, development and implementation of energy management system.

Student workload

The total volume of the discipline is 120 hours. (4 ECTS credits): lectures – 24 hours, practical classes – 12 hours, independent work – 84 hours.

Course prerequisites

Previous disciplines:
Discipline "Introduction to the specialty. Introductory practice"

Features of the course, teaching and learning methods, and technologies

Lectures are held interactively using multimedia technologies.
Practical tasks are performed using PCIRmeter open software and the Microsoft 365 platform.
Educational materials are available for students on the website of the discipline thermography.online.

Program of the course

Topics of the lectures

Topic 1. Introduction to thermography.

Topic 2. Principles of infrared thermography.
Heat and Heat Transfer, Basics of Heat Conduction, Fourier's Law of Heat Conduction, Thermal Conductivity/Resistance, Basics of Convection, Newton-Richmann Law (Basic Law of Heat Transfer), Basics of Radiation, Electromagnetic Spectrum, Atmospheric Transmission, Infrared Wave Ranges and Optical Materials for Thermography, Exemplary sources of infrared radiation, Planck's law, Wien's displacement law, Stefan-Boltzmann's law, radiation, reflection and transmission coefficients, emissivity, factors influencing emissivity.
Topic 3. Equipment for thermography and data collection.
Principles of thermal imager operation, Thermal imager selection criteria, spectral range, Temperature measurement range, Thermal sensitivity (NETD), lens selection, optical resolution, Equipment operation, Attachments and auxiliary devices, Thermal imager control functions, ISO 18434-1, Safety measures during data collection, Obtaining a good quality image, image composition, Image clarity (optical focus), Setting temperature parameters (range, level, resolution), palette selection, Determination of emissivity, Detection, elimination and prevention of image errors, Waveband selection criteria, Detection and compensation of reflected radiation, Detection and compensation of convection effects, Detection and compensation of conduction effects, Influence of insufficient emissivity. calibration of thermal imagers. Environmental conditions and operating mode of the object, Storage of data and images.
Topic 4. Image processing.
temperature measurement, ISO 18434-1, Non-contact thermometry, Comparative quantitative thermography, Comparative qualitative thermography, Influence of environmental conditions, Thermal imager measuring devices, Measuring instrument, palette selection, Level and resolution adjustment, Distance correction (atmospheric conditions), Radiation correction ability, Statistical analysis, subtraction of images, montage of images, Building a temperature trend, General guidelines for image interpretation, General guidelines for establishing temperature condition criteria (ISO 18434-1, standards, rules of technical operation).
Topic 5. General applications
Typical applications of thermography in industry, Active and passive thermography.
Topic 6. Diagnosis and forecasting
Basic principles of diagnosis (ISO 13379), Basic principles of forecasting (ISO 13381-1).
Topic 7. Application of state control methods
Principles of the device of machines (structures and nodes), Typical malfunctions of machines, their causes and associated temperature signs, Evaluation of the temperature state and acceptance criteria (rules of technical operation, standards), Safety of operation of machines, ISO 18434-1.
Topic 8. Corrective actions
Corrective and preventive actions related to the operation of machines.
Topic 9. Reporting and normative documents (national, regional and international standards)
Compiling reports, Responsibilities of thermographers and end users.

Topics of the workshops

Topic 1. Obtaining thermograms of the educational building under satisfactory weather conditions.
Topic 2. Laboratory determination of the reflection coefficient of various materials.
Topic 3. Familiarization with thermal image processing software.
Topic 4. Drawing up a report on a thermographic survey using specialized software

Topics of the laboratory classes

Self-study

Calculation task "Compilation of a report on a thermographic survey of a solar power plant."
Volume: 15-20 p. Submission deadline: 16th week.
Completion of online courses on educational platforms on the subject of the discipline (optional):
Online course Infrared Thermography - Essentials Guide on the Udemy platform, free access to the materials of the platform is provided by the teacher submitting registration lists to the director of the scientific and technical library of NTU "KhPI
Thermography basics online course on the SKF e-learning platform, available without registration

Course materials and recommended reading

Educational resource thermography.online
Introduction to Thermography basics 2014 Infrared Training Center
Introduction to Thermography 2009 American Technical Publishers, Inc., Fluke Corporation, and The Snell Group.
Introduction to Thermography Principles. 2009 American Technical Publishers, Inc., Fluke Corporation, and The Snell Group.
Introduction to Infrared Thermography. 2007 Jeff Beard
Makhotilo K. V., Lysenko L. I., Bulgakov O. V. O 75 Fundamentals of thermography: a study guide. / K.V. Makhotilo, L. I. Lysenko, O. V. Bulgakov. Kharkiv: FLP Panov A.M., 2021. 106 p.

Assessment and grading

Criteria for assessment of student performance, and the final score structure

The final assessment consists of:
30 points for two modular test papers,
20 points for completing laboratory tasks,
30 points for practical assessment (calculation task, performance of practical tasks, non-formal education (additional points for having a certificate of completion of an online course with thematic correspondence, for participation in competitions of student scientific works and olympiads on the subject of the discipline))
20 points per exam.

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by	Date, signature	Head of the department Oleksandr LAZURENKO
	Date, signature	Guarantor of the educational program Kostiantyn MAKHOTILO