Syllabus
Course Program

Control and Management of Chemical-Technological Processes

Specialty
161 – «Chemical Technologies and Engineering»

Institute
Institute of Computer Modeling, Applied Physics and Mathematics

Educational program
Technology of oil, gas and solid fuel refining

Department
Automation of Technological Systems and Environmental Monitoring (174)

Level of education
First (Bachelor's) Level.

Course type
Special (professional),

Semester
6

Language of instruction
English, Ukrainian

Lecturers and course developers

Roman Mykhailovych Vorozhbiian
Email: Roman.Vorozhbiian@khpi.edu.ua
PhD, Associate Professor, Associate Professor at the Department of Automation of Technological Systems and Environmental Monitoring.
Total number of publications: 40.
Work experience: 8 years.
Main courses taught:
Installation, Repair, and Adjustment of Automation Devices and Means.
Automation of Production and Environmental Monitoring Devices.
Control and Management of Chemical-Technological Processes.
For more detailed information about the instructor, please refer to the department's website.
https://web.kpi.kharkov.ua/acem/uk/welcome/

General information

Summary

The discipline "Control and Management of Chemical-Technological Processes" develops the ability in students to choose and apply methods for measuring technological parameters (pressure, temperature, flow rate, gas composition, concentration of solutions, etc.), devices and types of control-measuring instruments, methods for calculating their measurement schemes and structural elements, devices and types of sensors, as well as the specifics of their application and operating rules.

Course objectives and goals

The goal is to introduce students of chemical specialties to fundamental concepts and teach them modern methods of measuring technological parameters. This includes familiarizing them with types of control-measuring instruments, sensors, and automation tools, as well as methods for monitoring and controlling the state of technological processes..

Format of classes

The course includes lectures, laboratory work, individual assignments, self-study, and consultations. The final assessment is through a credit.

Competencies

The ability to choose and utilize appropriate equipment, tools, and methods for the control and management of technological processes in chemical production. (К13).

Learning outcomes

The ability to select and utilize appropriate equipment, tools, and methods to solve complex problems in chemical engineering, control, and management of technological processes in chemical production. (ПР07).

Student workload

The total workload for the course is 90 hours (3 ECTS credits): lectures - 12 hours, laboratory sessions - 24 hours, independent study - 54 hours. Assessment is done through a credit

Course prerequisites

The course is based on the following disciplines: General and Inorganic Chemistry, Organic Chemistry, Physics, Higher Mathematics, Processes and Apparatus of Chemical Productions, General Chemical Technology.

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

The course allows students to explore the latest methods of control and management in chemical production, understanding the instruments used and how they operate. Throughout the learning process, students receive interactive information that shapes their professional skills and provides a comprehensive understanding of the specificities involved.

Program of the course

Topics of the lectures

Topic: General Information on Composition and Classification of Automation Tools, Their Key Technical Characteristics. Methods of Measuring Quality and Substance Composition. This topic covers the composition and classification of automation tools, emphasizing their essential technical features. It includes methods for measuring the quality and composition of substances, along with the classification of tools for controlling and managing technological processes. The discussion outlines the main characteristics of instruments, measurement methods, and types of errors. Additionally, it explores the classification of gas analyzers and liquid analyzers, with a specific focus on magnetic gas analyzers, detailing their construction and operational principles.

Topic: Pressure Measurement.
This topic focuses on pressure measurement, starting with the classification of pressure measurement tools. It explores the construction and operational principles of liquid manometers, deformation-sensitive pressure measurement elements, and electrical pressure transducers. The selection, installation, and principles of operation of pressure measurement devices are discussed.

Topic: Level Measurement.
The subject of level measurement is explored through the classification of level measurement tools. This includes visual level indicators, their construction, and various types. Buoyancy and float level indicators are discussed, emphasizing their operational principles and differences. The construction and principles of operation of hydrostatic level indicators, as well as acoustic and ultrasonic level indicators, are covered.

Topic: Flow Rate Measurement.

This topic involves the classification of tools for measuring flow rates. It explores the measurement of flow rates using the constant pressure drop method, including the construction and operational principles of gas and liquid flow meters. The rules for installing variable pressure drop flow meters are discussed, along with the measurement of flow rates using the dynamic head method.

Topic: Temperature Measurement.
This topic covers the classification of temperature measurement tools, focusing on resistance thermometers. It explores the construction and operational principles of resistance thermometers, instruments for working with them, and the relationship between the resistance of a resistance thermometer and temperature. The construction and principles of operation of a logger and its device are also discussed.

Topic: Temperature Measurement.
This section delves into thermoelectric transducers, detailing their construction and operational principles. It discusses instruments for working with thermoelectric transducers, standard gradations of thermoelectric transducers, and their characteristics. The electrical connections of thermocouples in a thermobattery are explained, along with radiometric and optical pyrometers.

Topic: Methods and Devices for Remote Indication of Instrument Readings.
This topic explores pneumatic systems for transmitting measurement information, including the schematic representation of pneumatic transmission systems. It covers the Celisina system and the differential-transformer system for information transmission.

Topic: Development of Automation Schemes.
This topic outlines the fundamental requirements and standards for automation schemes. It introduces the conditional functional diagrams of automation and provides examples of developing functional automation diagrams in the oil and gas extraction industry..

Topics of the workshops

.

Topics of the laboratory classes

Topic: Calibration and Testing of Electrical Contact Pressure Gauge within Specified Pressure Limits. This topic covers the operational principle and construction of an electrical contact pressure gauge. It includes calculating the gauge scale range, defining the zone of insensitivity of the contact device, the purposes of using electrical contact pressure gauges, and the structure and operation of the EKM signaling system.

Topic: Measurement of Level with Differential Pressure Gauge and Pneumatic Transmission to Secondary Instrument. This topic explores the principles and construction of hydrostatic level gauges, pneumatic transmission systems, classification of level measurement methods, and the concept of the zone of insensitivity in secondary instruments.

Topic: Measurement of Level with Buoyancy Level Gauge Using Celisina Transmission of Readings to Secondary Instrument. This topic delves into the principles and construction of buoyancy level gauges, Celisina transmission systems, the variation of secondary instrument, the use of Celisins, and methods of level measurement.

Topic: Measurement of Liquid Flow by Constant Pressure Drop Method with a Differential Transformer Transmission System. This topic covers the principles and construction of rotameters, differential transformer transmission systems, how a constant pressure drop is maintained in a rotameter, the essence of the constant pressure drop method, and the classification of flow measurement methods.

Topic: Graduation of Resistance Thermometer. This topic discusses the construction and principles of resistance thermometers, basic graduations of electrical resistance thermometers, the purpose of bifilar winding, secondary instruments working with electrical resistance thermometers, and the use of Cu and Pt in resistance thermometers.

Topic: Verification of Graduation of Temperature Scale of Electronic Automatic Instruments. This topic involves establishing the instrument's accuracy class based on experimental data, the arms and diagonals of an electronic automatic bridge, the operational principle of the bridge measuring circuit, requirements for the balance of an automatic bridge, and identifying faults if the pointer reaches the end of the scale.

Topic: Graduation of a Logometer for Temperature Measurement. This topic covers the operational principle and construction of a logometer, the number of circuits in the scheme, the sensors used for temperature measurement, the concept of instrument verification, and the indication of induced errors.

Topic: Measurement of Temperature with an Optical Pyrometer. This topic explains the operational principle and construction of an optical pyrometer, defining the brightness temperature of an object, determining the true temperature of a heated object, the law on which the operational principle is based, and the purpose of red and gray light filters.

Topic: Measurement of Temperature with a Radiation Pyrometer. This topic covers the operational principle and construction of a radiation pyrometer, the law on which the operational principle is based, the concept of an absolutely black body, types of pyrometers, and the classification of temperature measurement methods.

Topic: Measurement of Oxygen Concentration with an Automatic Thermomagnetic Gas Analyzer. This topic explores the operational principle of a thermomagnetic gas analyzer, the construction of the gas analyzer sensor and its measuring electrical circuit, the procedure for starting the gas analyzer, determining induced errors, and the classification of concentration measurement methods.

Self-study

In addition to consolidating lecture material, it involves studying additional theoretical material according to the list of questions provided in the respective guidelines. Students also independently process theoretical material during the preparation for laboratory sessions. Self-preparation involves using printed and electronic textbooks, educational guides (with free access for all participants in the educational process), as well as other local and network information resources.
Processing of lecture material. Completion of individual assignments. Independent study of topics and questions not covered in lectures.

Course materials and recommended reading

1.Love, Jonathan Process automation handbook : a guide to theory and practice 1. Process control 2.Automation I. Title 670.4’27 ISBN-13: 9781846282812 ISBN-10: 1846282810 Library of Congress Control Number: 2007927990 ISBN 978-1-84628-281-2 e-ISBN 978-1-84628-282-9 Printed on acid-free paper ?c Springer-Verlag London Limited 2007
2.Dunn, William C. Introduction to instrumentation, sensors, and process control. —(Artech House sensors library) 1. Engineering instruments 2. Electronic instruments 3. Process control I. Title 681.2 ISBN-10: 1-58053-011-7 Cover design by Cameron Inc. 2006
3.Lessons In Industrial Instrumentation c 2008-2022 by Tony R. Kuphaldt – under the terms and conditions of the Creative Commons Attribution 4.0 International Public License
4.George Stephanopoulos – Chemical Process Control: An Introduction to Theory and Practice. Prentice Hall Int. Series in the Physical and Chemical Engineering Sciences (1984)
5.William C. Dunn. Fundamentals of Industrial Instrumentation and Process Control. McGraw-Hill eBook, 2005, 337 p. DOI: 10.1036/0071466932
6.Process systems analysis and control.—3rd ed. / Donald R. Coughanowr, Steven E. LeBlanc. p. cm.—(Mcgraw-Hill chemical engineering series) Includes index. ISBN 978–0–07–339789–4—ISBN 0–07–339789–X (hard copy : alk. paper) 1. Chemical process control. I. LeBlanc, Steven E. II. Title. TP155.75.C68 2009
7.Process control : a practical approach / Michael King. p. cm. Includes bibliographical references and index. ISBN 978-0-470-97587-9 (cloth) 1. Chemical process control. I. Title. TP155.75.K56 2011 660’.2815–dc22

8.Process Control Instrumentation Technology Curtis D. Johnson Eighth Edition Edinburgh Gate Harlow Essex CM20 2JE England and Associated Companies throughout the world Visit us on the World Wide Web at: www.pearsoned.co.uk © Pearson Education Limited 2014

Assessment and grading

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

The final grade is determined by the evaluation results in the form of an exam (20%) and ongoing assessment (80%). Exam: oral presentation, case solving. Ongoing assessment: completion of laboratory work (15%), individual assignments (50%), and writing control papers (15%).

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 DZEVOCHKO

Date, signature

Guarantor of the educational program
Irina SINKEVICH