COURSE DESCRIPTION CARD - SYLLABUS

Course name
Methods of Technical Problem Solving [S2Teleinf2>MRPT]

Course

Field of study
Teleinformatics

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
14

Laboratory classes
24

Other
14

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Knowledge: basic knowledge of engineering and management, mathematics (core curriculum for secondary schools, basic level). Skills: the ability to solve elementary problems of engineering based on possessed knowledge, usage of mathematical and engineering issues, and the ability to acquire information from indicated sources. Social competencies: understanding the need for further education; willingness to cooperate with a team.

Course objective

C1) Obtaining knowledge of engineering problems solving methods (simple and advanced) in the scope determined by the content of the curriculum, appropriate for the field of study C2) Development of skills to solve simple and advanced engineering problems, perform simple and advanced analysis of problem-solving based on gained knowledge. C3) Acquainting with practical understanding and application of teamwork rules as well as using quality management methods and techniques. C4: Assurance of understanding key objectives of teamwork in an organization as well as applying methods and techniques supporting decision-making in quality management.

Course-related learning outcomes

Knowledge:
W1) Understanding Basic Engineering Concepts: Students will be able to define and comprehend fundamental engineering concepts within the scope of the course content. This knowledge will provide a strong foundation for further studies and practical application in their field of study. K2_W05, K2_W07
W2) Proficiency in Engineering Problem Solving: Students will deepen their knowledge of solving engineering problems by utilizing both simple and advanced problem-solving methods. This includes the ability to analyze and address complex engineering challenges using appropriate techniques, fostering their problem-solving skills. K2_W05, K2_W07, K2_W11
W3) Enhancing Creative Thinking and Decision-Making: Students will develop and broaden their creative thinking abilities. They will learn to classify problem-solving methods and techniques, enabling them to select the most suitable approach in a given situation. K2_W07, K2_W11

Skills:
U1) Information Retrieval and Integration: Students will develop the ability to gather relevant information from various sources such as literature, databases, and carefully selected references. They will learn to extract essential details and integrate this information into their work. K2_U03, K2_U04, K2_U09, K2_U15
U2) Problem-Solving and Analysis: Students will acquire the capability to choose appropriate problem-solving methods for engineering problems. They will learn to conduct basic-level analyses, which involve breaking down complex issues into manageable components, evaluating different approaches, and selecting the most suitable solution. K2_U02, K2_U07, K2_U09, K2_U13, K2_U15, K2_U16
U3) Communication and Quality Management: Students will develop proficiency in discussing the validity of ideas and addressing organizational barriers within work teams. They will also gain knowledge of quality management methods and techniques, enabling them to apply quality standards to their work. K2_U02, K2_U04, K2_U05, K2_U16, K2_U18, K2_U19, K2_U20

Social competences:
S1) Active Listening and Analysis: Students develop the ability to listen to and analyze the content discussed actively. This skill allows them to understand and interpret information effectively, enabling them to engage in critical thinking and decision-making processes. K2_K01, K2_K03, K2_K04, K2_K05
S2) Collaboration and Responsibility: Students learn to work effectively in teams, taking on individual and collective responsibilities. They actively participate in analyzing problems and finding solutions while also demonstrating cooperative skills and the ability to set priorities for task implementation. K2_K03, K2_K04, K2_K05, K2_K06

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures
Problem-solving task: a case study that requires teamwork to analyze and resolve issues (4 points). Evaluation of teamwork skills, priority setting, and proposing effective solutions (3 points). Assessment of critical thinking, problem-solving skills, and teamwork dynamics (3 points).
A maximum of 10 points can be obtained. To achieve a grade of 3.0, a minimum of 50% of the points is required; 3.5 - 60% of the points; 4.0 - 70% of the points; 4.5 - 80% of the points; 5.0 - 90% of the points.
The grading scale is as follows: very good (A) - 5.0; good plus (B) - 4.5; good (C) - 4.0; satisfactory plus (D) - 3.5; satisfactory (E) - 3.0; fail (F) - 2.0.
Labs
Observational assessments: evaluating the ability to actively listen, collaborate effectively, and participate in group discussions, as well as the level of engagement in problem-solving processes (3 points). Checklists to provide constructive feedback (2 points). Evaluation of the presentation of developed results/solutions (5 points).
For each laboratory exercise, a maximum of 10 points can be obtained. To achieve a grade of 3.0, a minimum of 50% of the points is required; 3.5 - 60% of the points; 4.0 - 70% of the points; 4.5 - 80% of the points; 5.0 - 90% of the points.
The grading scale is as follows: very good (A) - 5.0; good plus (B) - 4.5; good (C) - 4.0; satisfactory plus (D) - 3.5; satisfactory (E) - 3.0; fail (F) - 2.0.

Programme content

Seven lecture topics provide an exploration of the fundamental role of creative thinking in solving technical problems. They offer an in-depth analysis of the characteristics and mindset of a creative problem solver, emphasizing the importance of fostering a creative environment to enhance the effectiveness of problem-solving endeavors:

1. Introduction to Creative Thinking in Technical Problem Solving:
a. Understanding the importance of creative thinking in technical problem-solving.
b. Exploring the characteristics and mindset of a creative problem solver.

2.Generating Innovative Ideas:
a. Techniques for generating a wide range of innovative ideas.
b. Brainstorming methods and tools for enhancing creativity.
c. Exemplary techniques like SCAMPER, random word association, and mind mapping.

3. Analyzing and Defining Technical Problems:
a. Approaches for analyzing and defining technical problems effectively.
b. Identifying the root causes and underlying factors contributing to a problem.
c. Utilizing problem-solving frameworks to gain clarity and insight.

4. Divergent Thinking Strategies:
a. Leveraging divergent thinking techniques to explore multiple solutions.
b. Encouraging unconventional and out-of-the-box thinking.
c. Exemplary techniques such as the "5 Whys" method and the Provocation approach.

5. Convergent Thinking Techniques:
a. Evaluating and selecting the most promising ideas.
b. Applying convergent thinking methods such as decision matrices and SWOT analysis.
c. Balancing creativity with practicality and feasibility.
d. Exemplary techniques like the Delphi method and Multi-Criteria Decision Analysis (MCDA).

6. Prototyping and Iterative Problem Solving:
a. Embracing prototyping as a means to test and refine ideas.
b. Understanding the importance of iteration in the problem-solving process.
c. Using feedback loops and rapid experimentation for continuous improvement.
d. Exemplary techniques like Rapid Prototyping and Design Thinking.

7. Enhancing Creative Problem-Solving Skills:
a. Developing creative problem-solving skills through practice and reflection.
b. Emphasizing the value of interdisciplinary thinking and knowledge integration.
c. Applying creative thinking to real-world technical challenges.
d. Exemplary techniques such as TRIZ (Theory of Inventive Problem Solving) and Six Thinking Hats.

Ten laboratory exercises and case studies provide hands-on experiences and practical applications of the creative problem-solving methods discussed in the lectures:

1. Brainstorming Session with Exemplary Techniques:
a. A group brainstorming session to solve a technical problem.
b. Exemplary techniques like SCAMPER, random word association, and mind mapping during the session.

2. Reverse Engineering Analysis and Innovative Modifications:
a. Complex product or system to perform a reverse engineering analysis.
b. Breaking down the components and functions, identifying potential improvements or innovative modifications.
c. Applying creative thinking techniques, such as the "5 Whys" method and Provocation approach, to generate alternative design concepts.

3. Design Challenge and Convergent Thinking:
a. Presenting a design challenge related to a specific technical problem.
b. Dividing students into teams with provided limited resources and constraints.
c. Developing innovative and practical solutions within the given parameters, using convergent thinking methods like decision matrices and SWOT analysis.

4. Case Study: Innovation in Industry with Exemplary Methods:
a. Analyzing a real-world case study that showcases innovative problem-solving methods in an industry of interest.
b. Exploring how creative thinking, including exemplary methods like TRIZ and Six Thinking Hats, played a crucial role in overcoming technical challenges and achieving success.

5. Idea Evaluation and Selection Exercise with Exemplary Techniques:
a. A set of ideas or solutions for evaluation, generated by students or extracted from real-life examples.
b. Assign each idea to different groups and have them evaluate and select the most promising ones using exemplary techniques like the Delphi method and Multi-Criteria Decision Analysis (MCDA).

c. Discussing the rationale behind the choices and comparing the results.
6. Prototyping, Testing, and Rapid Iteration:
a. Introducing a hands-on prototyping exercise using available materials and tools.
b. Creating physical or digital prototypes of designed concepts.
c. Test and iterate the prototypes rapidly, incorporating feedback and improvements.
7. Simulation-Based Problem Solving with Exemplary Methods:
a. Utilizing simulation software or virtual environments to simulate technical problems.
b. Assign students different scenarios to explore and solve using creative thinking approaches, including exemplary methods like TRIZ and Design Thinking.
c. Analyzing the results and discussing the effectiveness of the problem-solving strategies.
8. Creative Thinking in Teamwork and Collaboration:
a. Forming teams and assigning each team a technical problem to solve collaboratively.
b. The importance of effective communication, idea sharing, and leveraging diverse perspectives.
c. Evaluating the team's creative problem-solving process and outcomes.
9. Real-time Innovation Challenge and Time Constraints:
a. Presenting a time-sensitive problem or constraint and challenging to come up with innovative solutions within a limited timeframe.
b. Encouraging fast-paced idea generation and rapid prototyping to foster creativity under pressure.
c. Incorporating exemplary methods and techniques discussed in the lectures during the challenge.
10. Innovation Competition:
a. An innovation competition where students or teams can showcase their creative problem-solving skills.
b. A specific problem statement or theme where participants apply various creative thinking methods and exemplary techniques.
c. Evaluation of the most innovative and effective solutions, considering their creativity, feasibility, and impact.

Course topics

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Teaching methods

1. Active Learning Techniques: Incorporating active learning strategies, such as group discussions, problem-solving activities, and case studies, to engage students actively in the learning process.

Encouraging collaborative learning and peer-to-peer interaction to foster critical thinking and knowledge application.
2. Technology Integration: Leveraging technology tools and platforms to enhance the learning experience. Use of online collaboration tools for brainstorming sessions, virtual simulations for problem-solving exercises, and multimedia presentations to deliver engaging content. Additionally, utilizing online discussion forums or learning management systems for asynchronous learning and resource sharing.
3. Case-Based Learning: Integrating real-world case studies into lectures and laboratories to demonstrate the practical application of creative thinking in solving technical problems. Encouraging students to analyze and discuss the cases, identifying creative solutions and reflecting on the decision-making process.
4. Peer Feedback and Peer Teaching: Incorporating peer feedback mechanisms, where students provide constructive feedback to their peers' problem-solving approaches or design solutions. Encouraging peer teaching sessions, where students can share their knowledge and creative techniques with their classmates.
5. Project-Based Learning: Integrating project-based learning into the curriculum, where students work on real-world problems or design challenges that require creative thinking. This approach allows students to apply their skills, conduct in-depth research, and develop innovative solutions through hands-on, experiential learning.

Bibliography

Basic:
Miller, B., Vehar, J. Firestien, R., Thurber, S., Nielsen, D. (2011). Creativity unbound: An introduction to the creative process (51 ed.). Evanston, IL: FourSight.
Puccio, G.J., Mance, M., Barbaro-Switalski, L., Reali, P. (2012). Creativity Rising: Creative thinking and creative problems solving in the 21st century. ICSC Press, Buffalo, NY.

Additional:
Szmidt K.J., ABC kreatywności, Difin, Warszawa 2010
Foster T.R.V., Kreowanie świetnych pomysłów na 101 sposobów, IFC Press, Kraków 2000
de Bono E., Myślenie lateralne: czym jest i jak wiele znaczy, Wydawnictwo Studio Emka, Warszawa 2015

Breakdown of average student's workload

	Hours	ECTS
Total workload	78	3,00
Classes requiring direct contact with the teacher	38	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50