# COURSE DESCRIPTION CARD - SYLLABUS

Course name
Expert systems and artificial intelligence [S2IBiJ1>SEiSI]

## Course

Field of study
Safety and Quality Engineering

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
15

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
0

## Number of credit points

2,00

## Coordinators

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## Lecturers

## Prerequisites

Student has knowledge of the basics of management and information technology carried out at first cycle studies. In addition, he should also be able to use the acquired knowledge in practice and is ready to work within team structures.

## Course objective

To interest the students of Safety Engineering course of the future problems of using Expert Systems as well as Artificial Intelligence methods and techniques in solving both technological and decision-making problems in this knowledge discipline.

## Course-related learning outcomes

Knowledge:
1. Student knows the methods, techniques, tools and materials used in solving simple engineering tasks and conducting experiments in the field of security with the use of information technologies, information protection, computer support, artificial intelligence and cyber security [K2_W11].
2. Student knows the concept of man and the world of values, the basic ethical categories, the role of man in ensuring the reliability of systems man-technical object, man-structure and crisis management

[K2_W12].

Skills:
1. Student is able to properly select sources and information derived from them, evaluate, critically analyze and synthesize this information, formulate conclusions and exhaustively justify an opinion on the structures and scopes of security engineering [K2_U01].
2. Student is able to perceive and formulate system and non-technical aspects as well as socio-technical, organizational and economic aspects in engineering tasks [K2_U03].
3. Student is able to use research, analytical, simulation and experimental methods to formulate and solve engineering tasks, also using information and communication methods and tools [ K2_U04].

Social competences:
1. Student is aware of the cause-and-effect relationships in the implementation of the set goals and the ranking of the importance of alternative or competitive tasks in the field of crisis safety and occupational safety management [K2_K01].
2. Student is aware of the recognition of the importance of knowledge in solving problems in the field of security engineering and continuous improvement [K2_K02].

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:
The knowledge acquired during the lecture is verified by carrying out a final written test consisting of a set of 10 questions. Passing threshold: 51% of correct answers (sufficient grade - 3.0).
The knowledge acquired during the exercises is verified on the basis of solving individual tasks included in the curriculum. For each task, the student receives points. Passing threshold: 51% of points (sufficient grade - 3.0).
Summative assessment:
Lecture: grade point average. Passing threshold 51%.
Classes: average of partial grades. Passing threshold 51%.
Grading scale in accordance with part C of the Regulations of First and Second Degree Studies adopted by the Academic Senate of the Poznań University of Technology.

## Programme content

The programme covers content related to the essence of Expert Systems, the possibilities of their use and artificial intelligence (AI).

## Course topics

Lecture:
Against the backdrop of definitions of concepts such as human intelligence, data, information, knowledge, and wisdom, definitions of Expert Systems and Artificial Intelligence are derived. In a similar context, classic issues of knowledge acquisition, methods of its representation in intelligent systems, creation and reconstruction of professional knowledge bases, and problem-solving strategies are developed. This part of the lecture is methodological in nature and deals, among other things, with heuristics and graph search strategies, as well as classical and fuzzy inference methods.
Expert Systems are presented in variants based on two-valued logic and as fuzzy systems. Among the Artificial Intelligence solutions classified as nature-based, textbook Artificial Neural Networks (in variants: Self-Organizing Maps and Learning Vector Quantization) and Evolutionary Algorithms (in variants: Genetic Algorithms, Evolutionary Strategies, Evolutionary Programming) are presented. In addition, so-called hybrid systems and elements of chaos theory are presented.
Issues related to management information system support (including Business Intelligence System solutions) and the economy based on intelligent digital technologies (with the issue of business security as a target of cyberattacks) are discussed in the context of the “intelligent dilemma of the sixth business cycle.”
The lecture also covers the concepts of Deep Machine Learning, Large Language Models, and Generative Artificial Intelligence, and, on this basis, the development of today's practical technological tools and artifacts of Artificial Intelligence, from ChatGPT through AI Agents to so-called Superintelligence.
Optionally, technological wars over access to and distribution of Artificial Intelligence processors are

presented. Also optionally (but outside the program), the lecturer offers students a presentation of the results of his own research on the issue of ergonomic benefits and threats resulting from the development of Artificial Intelligence.

Tutorials: This type of classes is implemented in a joint form with the tutor of student analysis exercises, team practical studies for the issues: a), b), c) and d) and jointly with the tutor of the analysis of an example problem prepared by him e). The list of exercises include: a) selected methods of symbolic knowledge representation in the field of security engineering for the purposes of creating and rebuilding professional knowledge bases, b) methods of building and searching knowledge graphs in the field of security engineering, c) operation on triangular and trapezoidal forms of membership functions for the purpose of inference in a fuzzy expert system of a selected issue of security engineering, d) preparation of training programs in the field of business security engineering in cyber threat conditions, e) generating in MATLAB an Artificial Neural Network with multilayer feedback and one hidden layer with 15 input nodes and one node in output layer (as a network learning algorithm - Levenberg Marquardt gradient back propagation, as a transfer function in both the input and output layers - hyperbolic tangent; the number of neurons in a hidden wa layer determined by trial and error, changing the number of neurons from the set: {7, 10, 13, 16, 19, 22, 25, 27, 29, 31}).

## Teaching methods

Information lecture in the form of a multimedia presentation, with elements of a conversational lecture. The lecture is conducted using distance learning techniques in a synchronous mode. Acceptable platforms: eMeeting, Zoom, Microsoft Teams.
Tutorials: auditorium exercises, task solving and case study.

## Bibliography

Basic:
1. Pacholski L. (2011), Systemy ekspertowe i sztuczna inteligencja, Wydawnictwo Politechniki Poznańskiej, Poznań.
2. Zieliński J.S. (red.) (2000), Inteligentne systemy w zarządzaniu, PWN, Warszawa.
3. Mulawka J.J. (1996), Systemy ekspertowe, WNT, Warszawa.
4. Rutkowska D., Piliński M., Rutkowski L. (1997), Sieci neuronowe, algorytmy genetyczne i systemy rozmyte, PWN, Warszawa.
5. Cytowski J. (1996), Algorytmy genetyczne. Podstawy i zastosowania, Akademicka Oficyna Wydawnicza, Warszawa.

Additional:
1. Medsker L.M. (1994), Hybryd Neural Networks and Expert Systems, Kluwer Academic Publisher, Boston.
2. Żurada J.M., Barski M., Jędruch W. (1996), Sztuczne sieci neuronowe, PWN, Warszawa.
3. Budrewicz J. (1993), Fraktale i chaos, WNT, Warszawa.
4. Pacholski L., 2022, Managerial Recommendations Concerning the Cybersecurity of Information and Knowledge Resources in Production Enterprises Implementing the Industry 4.0 Concept, Management and Production Engineering Review, vol. 13, nr 3, pp. 30-38

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 60 | 2,00 |
| Classes requiring direct contact with the teacher | 30 | 1,50 |
| Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation) | 30 | 0,50 |