COURSE DESCRIPTION CARD - SYLLABUS

Course name
Information theory [S1MNT1>K-TI]

Course

Field of study
Mathematics of Modern Technologies

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

The student should have previously mastered the following subjects: Probability, Mathematical Statistics, Discrete Mathematics, Introduction to Programming.

Course objective

The aim of the course is to familiarize students with the basics of information theory, especially the concept of entropy, and to use this knowledge in practice, e.g. in cryptography, data compression and machine learning.

Course-related learning outcomes

Knowledge:
• knows and understands issues in the field of technical sciences, including automation, robotics, electrical engineering and electronics to a sufficient degree [K_W04(P6S_WG)];
• knowsandunderstandstherelationshipbetweenmathematicsandmoderntechnologies[K_W05(P6S_WG)];
• knows and understands issues in computer science, including numerical methods; knows at least one software package, programming language [K_W07(P6S_WG)];
• knows and understands engineering technologies and is aware of the latest development trends in the

field of study [K_W11(P6S_WG)].

Skills:
• can use mathematical tools and methods, including numerical ones, to solve engineering problems [K_U03(P6S_UW)];
• canapplymoderntechnologiestosolvemathematicalandengineering-technicalproblems[K_U05(P6S_UW)];
• can use mathematical tools to support and develop modern technologies used in engineering and technical sciences [K_U06(P6S_UW)].

Social competences:
• is ready to critically assess the level of his/her knowledge in relation to research in exact and natural sciences as well as engineering and technical sciences [K_K01(P6S_KK)];
• is ready to deepen and expand knowledge to solve emerging technical problems [K_K02(P6S_KK)].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures: knowledge is verified on a written test;
Laboratory classes: knowledge and skills are verified on the basis of the evaluation of the programming colloquium;
Projects/seminars: knowledge and skills are verified based on the assessment of project implementation, its functionality and goals;
Grading scale: 0%-49% - NDST, 50%-59% - DST, 60%-69% - DST+, 70%-79% - DB, 80%-89% - DB+, 90%-100%-BD.

Programme content

- Basics of statistical information theory
- Notion of entropy,
- Classic information theorems
- elements of data compression

Course topics

Lectures
• sources of information and their coding;
• Sardinas-Patterson theorem; Kraft-McMillan inequality;
• Huffman coding;
• Shannon information and entropy;
• Shannon’s source coding theorem;
• Shannon-Fano coding;
• information channel;
• channel entropies and mutual information; channel capacity;
• decision rules and Hamming distance;
• Shannon’s fundamental theorem;
• minimum code distance;
• Hamming and Gilbert-Varshamov constraints;
• Hadamard codes;
• linear codes;

Lab:
Using software tools:
- entropy calculation
- approximation of natural language
- Huffman coding, startless compression (LZW method)

Teaching methods

Lectures: multimedia presentation, presentation illustrated with examples given on the board, problem so-

lving, multimedia show, demonstration;
Laboratory classes: solving practical problems, discussion, individual or team work.

Bibliography

Basic:
• James V Stone: Information Theory, A Tutorial Introduction, Sebtel Press 2014;
• Fady Alajaji, Po-Ning Chen: An Introduction to Single-User Information Theory, Springer 2018;
• Cover, T. and Thomas, J.: Elements of Information Theory. New York, John Wiley and Sons, 1991;
• Shannon, C.: A mathematical theory of communication, Bell System Technical Journal, 27:379-423. (1948).

Additional:
• J. Nowakowski, W. Sobczak, Teoria Informacji, WNT (1971);
• H. Górecki: Teoria informacji, Wydawnictwo Wyższej Szkoły Informatyki w Łodzi (2006);
• Z. Łukasik, Teoria informacji i sygnałów, Wydawnictwo Uniwersytetu Technologiczno-Humanistycznego 2013;
• Z. Łukasik: Teoria informacji i bezpieczeństwa transmisji, wydawnictwo: Politechnika Radomska (2012);
• D. R. Stinson: Kryptografia. W teorii i praktyce, Helion, 2021;
• Applebaum, D.: Probability and Information An Integrated Approach, 2nd Edition. Cambridge University Press (2008);
• Baeyer, H.: Information: The New Language of Science. Harvard University Press (2005);
• Bishop, C.: Pattern Recognition and Machine Learning. Springer (2006);
• Guizzo, E.: The essential message: Claude Shannon and the making of information theory(2003);
• http://dspace.mit.edu/bitstream/handle/1721.1/39429/54526133.pdf - MIT;
• Jessop, A. Informed Assessments: An Introduction to Information, Entropy and Statistics. Ellis Horwood, London (1995);
• Lemon, D.: Student’s Guide to Entropy. Cambridge University Press (2013).

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50