**JSC «Kazakh-British Technical University»**

**Faculty of Information Technology**

**Chair of Information Systems Management**

**APPROVED BY**

**Dean of FIT**

**Suliyev R.N. \_\_\_\_\_\_\_\_\_**

**«\_\_\_\_»\_\_\_\_\_\_\_\_\_\_ 2021.**

**SYLLABUS**

**Discipline:** Introduction of Informational Systems

**Number of credits: 3 (3/0/0)**

**Term:** Autumn

**Instuctor’s full name: Pak Alexandr**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Personal Information about the Instructor** | **Time and place of classes** | | **Contact information** | |
| **Lessons** | **Office Hours** | **Tel.:** | **e-mail** |
| **Pak Alexandr**  **Assistant Professor** | According to the schedule | According to the schedule | 87017529285 | a.pak@kbtu.kz  aa.pak83@gmail.com |

**Course duration:** 3 credits, 15 weeks (60 class hours)

**Course pre-requisites:** python programming, basic probability theory, linear algebra, differential calculus

**Course Objectives:**

The Introduction to Information Systems is the undergraduate course of curriculum.

The main objective of the course offers an introduction to the quantitative theory of information and its applications to reliable, efficient communication systems. Topics include mathematical definition and properties of information, source coding theorem, lossless compression of data, optimal lossless coding, noisy communication channels, channel coding theorem, the source channel separation theorem, multiple access channels, broadcast channels, Gaussian noise, and time-varying channels..

**Course Goals:**

Through theoretical study, problem solving and laboratory practice, this course provides a foundation in the Information Theory models and methodologies. After successfully completing the course, students are able to:

At the completion of this course, the student should be able to:

1) Demonstrate knowledge and understanding of the fundamentals of information theory.

2) Take into account the internal representation of communication systems. Understand its limits and advantages.

3) Demonstrate a developed deeper understanding of application information theory in machine learning.

4) Apply the concepts of information theory to various disciplines in information science.

**Literature:**

**Required:**

1. Elements of Information Theory (SE), Thomas M. Cover, Joy A. Thomas, Wiley Interscience, 2006
2. Information Theory, Inference, and Learning Algorithms, David J.C. MacKay, Cambrdige University Press, 2003

**Supplementary:**

1. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012
2. Pattern Recognition and Machine Learning. Christopher Bishop, 2006

Foundations of Machine Learning, Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, MIT Press, 2012

**COURSE CALENDAR**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Week | **Class work** | | | | | **SIS**  **(students independent study)** | | | **TSIS**  **(teacher supervised independent study)** | |
| **Topic** | **Lectures, hours** | **Lab, hours** | **Seminars, hours** | **Chapters for reading** | **Hours** | **Description** | | **Hours** | **Description** |
| 1 | **Lecture #1. The introduction to IT**  *Entropy, Mutual Information*  *Chain rule*  ***Lab work introduction*** | 2 | 1 |  | [1] 2.1-2.5 | 1 |  | | 4 | Project start (initiation) |
| 2 | **Lecture #2. Informational inequalities**  Jensen’s Inequality  Log Sum Inequality  Fano’s Inequality  ***Lab work #1*** | 2 | 1 |  | [1] 2.6-  2.10 | 1 |  | | 4 |  |
| 3 | **Lecture #3. Convergence**  Asymptotic equipartion property (AEP)  Joint typicality  ***Lab work #2*** | 2 | 1 |  | [1]  3.1-3.3 | 1 |  | | 4 |  |
| 4 | **Lecture #4. Entropy of stochastic process**  Markov chains  Entropy Rate of a Random Weighted Graph  ***Lab work #3*** | 2 | 1 |  | [1]  4.1-  4.3 | 1 |  | | 4 | Checkpoint 1 |
| 5 | **Lecture #5. Data Compression**  Kraft Inequlaity  Huffman Codes  Optimal Codes  ***Lab work #4*** | 2 | 1 |  | [1]  5.1-5.3  5.6  5.8 | 1 |  | | 4 |  |
| 6 | **Lecture #6. Gambling and Data Compression**  The Horse Race  Gambling and Side Information  Entropy of gambling  ***Lab work #5*** | 2 | 1 |  | [1]  6.1-6.3 | 1 |  | | 4 | Checkpoint 2 |
| 7 | **Lecture #7. Channel Capacity**  Channel coding theorem  Hamming Codes  ***Lab work #6*** | 2 | 1 |  | [1]  7.1  7.7  7.11 | 1 |  | | 4 |  |
| 8 | ***Midterm*** |  |  |  |  |  |  | |  |  |
| 9 | **Lecture #9. Differential Entropy**  ***Lab work #7*** | 2 | 1 |  | [1]  8.1-8.3 | 1 |  | | 4 |  |
| 10 | **Lecture #7. Gaussian Channel**  ***Lab work #7*** | 2 | 1 |  | [1]  9.1-9.3 | 1 |  | | 4 | Checkpoint 4 |
| 11 | **Lecture #10. Rate Distortion Theory**  ***Lab work #8*** | 2 | 1 |  | [1]  10.1-10.3 | 1 |  | | 4 |  |
| 12 | **Lecture #11. Information Theory and Statitics**  1. Dimension reduction.  2. Principal components analysis (PCA)  ***Lab work #8*** | 2 | 1 |  | [1]  11.1-11.3 | 1 |  | | 4 |  |
| 13 | **Lecture #13. Maximun Entropy**  ***Lab work #9*** | 2 | 1 |  | [1]  12.1-12.3 | 1 |  | | 4 | Checkpoint 5 |
| 14 | **Lecture #14. Network Information Theory** | 2 | 1 |  |  | 1 |  | | 4 |  |
| 15 | **Lecture #15. Final project defense** | 2 | 1 |  | [1] 15.1-15.3 | 1 |  | | 4 | Final Presentation |
|  | **Final Exam** |  |  |  |  | **In written form** | | | | |
|  | **Total** | **30** | **30** | **0** |  | **15** | |  | **6** |  |

**COURSE ASSESSMENT PARAMETERS**

|  |  |
| --- | --- |
| **Type of activity** | **Finalscores** |
| Exercises, assignments | 60 |
| Quiz | 0 |
| SIS | 0 |
| Midterm | 0 |
| Project | 40 |
| **Total** | **100%** |

**Criteria for evaluation of students during semester:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Assessment criteria** | **Weeks** | | | | | | | | | | | | | | | | **Total scores** |
|  | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16-17** |
| 1. | Attendance/participation | \* | \* | \* | \* | \* | \* | \* | \* | \* | \* | \* | \* | \* | \* | \* |  | 0% |
| 2. | Assignments |  | \* | \* | \* | \* | \* | \* |  | \* | \* | \* | \* | \* | \* |  |  | 60% |
| 3. | Final Project Presentation |  |  |  |  |  |  |  |  |  |  |  |  |  | \* | \* |  | 20% |
| 4. | Midterm |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0% |
| 5. | Final Exam |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | \* | 20% |
|  | **Total** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **100%** |

**Academic Policy**

KBTU standard academic policy is used.

- The teacher reserves the right to change the syllabus and notify the students in advance.

* Cheating, duplication, falsification of data, plagiarism, and crib are not permitted under any circumstances!
* Attendance is mandatory.

**Attention**. Missing 20% attendance to lessons, student will be taken from discipline with filling in F (Fail) grade.

Students must participate fully in every class. While attendance is crucial, merely being in class does not constitute “participation”. Participation means reading the assigned materials, coming to class prepared to ask questions and engage in discussion.

* Students are expected to take an active role in learning.
* Written assignments (independent work) must be typewritten or written legibly and be handed in time specified. Late papers are not accepted!
* Students must arrive to class on time.
* Students are to take responsibility for making up any work missed.
* Make up tests in case of absence will not normally be allowed.
* Mobile phones must always be switched off in class.
* Students should always be appropriately dressed (in a formal/semi-formal style).
* Students should always show tolerance, consideration and mutual support towards other students.