Course Outline

COURSE TITLE	Data Structure
NAME OF LECTURER	Marcin Kowalczyk

COURSE DESCRIPTION

This course is designed to introduce students to database systems and data structures used in such kind systems commonly. During the course the methodology of modeling, design and implementation of the relational databases will be presented. Also, at the end of the course the NoSQL databases together with data structures and algorithms used at them are presented. The concept of Big Data systems is also presented. The expected effect of the course is teach students how to design and deploy relational databases, including how to design appropriate data structures as well as how to deploy a client application in a form of Graphical User Interface (GUI), based on Java technology (JDBC, JavaFX), which cooperates with the database - understood here as the so-called backend tier. The integral part of the course is a project, which includes a design of own relational database with appropriate data structure to hold data, as well a client application in a GUI form. To be part of the course no special skills or previous preparation are required, however it is expected that a student knows the fundamentals of at least one object-oriented programming language like Java for example. A lot of lectures have a form of interactive workshops (live presentations). During them among others is presented a whole process of design and deploy of both relational database as well a client application, which cooperates with it, based on a realistic case.

RECOMMENDED READINGS

There are no special requirements related with previous preparation to the course. All necessary materials in a form of power point presentations, e-books or software installers will be provided by the lecturer at the beginning of the course.

A list of example books, which can be useful during the course:

1. T. Connolly, C. Begg, Database systems – a practical approach to design, implementation, and management, four edition, Addison Wesley, 2005

2. H. Garcia-Molina, Database systems – the complete book, Pearson, 2014

3. J. Vos, W. Gao, S. Chin, D. Iverson, and J. Weaver, Pro JavaFx 8, A Definitive Guide to Building Desktop, Mobile, and Embedded Java Clients, APRESS, 2014

TEACHING METHODS

The course is realized in a mixed form of lectures with discussion based on a PPT presentations with interactive shows of discussed issues based on a real systems with relation to realistic cases. Also, thirty percent of all hours during the course have a form of interactive workshop where example of the project is realized.

ASSESSMENT METHODS

Midterm exam 20%, Final exam 20%, Project (first part – a database design project) 20%, Project (second part – client application) 20%, Class Participation 20%

CLASS TOPICS *(each class is 3 hrs)*

Class 1: Introduction to databases and used data structures in them. Main concepts, terms and use

cases are discussed. Database Environment - difference between a database, metadata and database management system. Expectations related to modern DBMS systems, main problems and their architecture. Characteristic of OLTP and OLAP systems.

Class 2: Transactions and relational data model. High-level database models, entity-relationship (ER) model, the UML and Crow Foot notations. Three phases of design and implementation of database, i.e. conceptual, logical and physical. Methodology of design and deploy of relational databases, data structures, keys. The concept of normalization - schema decomposition, 3rd normal form and Boyce-Code form, multi-variant dependencies, data integrity.

Class 3: Relational algebra and relational calculus. Problem with ER models – fan and chasm traps. Enhanced ER modeling (specialization – generalization, composition and aggregation). The idea of denoralization (redesign of data structures) and its consequences.

Class 4: *1st homework assignment* (relational database design and implementation project) – requirements discussion. Design of relational databases based on realistic case study in a form of the interactive workshop (first part).

Class 5: Introduction to SQL (Structured Query Language). Query processing, DDL, DML, DCL and DQL operations. Design of relational databases based on realistic case study in a form of the interactive workshop (second part).

Class 6: The SQL language continuation: sorting, joins and groupings, multi-tables queries, views.

Class 7: Selected database issues – integrity and multi-access (concurrent operations). Database transactions and management of concurrent data access – ACID properties.

Class 8: Mid-term Exam.

Class 9: Introduction to monitoring and optimization the DBMS efficiency Understanding a database indexes as data structures that improves the speed of data retrieval. Indexes types and their structures and criteria their application. B-tree data structures and their efficiency.

Class 10: A client-server vs. multi-tier architecture. Creation the applications, which cooperate with databases. SQL/CLI, ODBC and JDBC interfaces specification. *2nd homework assignment* (the client application project) – requirements discussion.

Class 11: Design and implementation of the client GUI application with Java - an interactive workshop (first part).

Class 12: Design and implementation of the client GUI application with Java - an interactive workshop (second part).

Class 13: Database Oracle as an instance of DBMS – architecture, database dictionary, redo logs and fundamentals of administration, SQL procedural extensions (programming of database).

Class 14: Introduction to NoSQL databases and Big Data systems – data structures. Classification of NoSQL databases, their application and main characteristics. The Big Data system concept. Structured and unstructured data.

Class 15: Presentation of the projects and Final Exam

SPECIAL COMMENTS

The course is an introductory to database systems and data structures used in them. It is expected that a student has access to laptop or personal computer, as it is necessary for doing the project.