<p style="text-align:center">Advanced Database Systems</p>

<p style="text-align:center">Autumn 2020-21</p>

Week 1

Lecture 1 (02/09/2020)
- Introduction to the course

Lecture 2 (03/09/2020)
- Recap of database indexing, B+ Tree
- Introduction to multi-dimensional indexing, high dimensional indexing
- Structure of R Tree

Lecture 3+4 (04/09/2020)
- R Tree
- Insert, delete and search algorithms
- Nearest neighbor search on R Trees
- Introduction to pruning strategies

Week 2

Lecture 5 (09/09/2020)
- Use of MINDIST and MINMAXDIST for NN search

Lecture 6 (10/09/2020)
- Other types of trees
- RStar, RPlus and SS trees
- High dimensional image database search

Lecture 7+8 (11/09/2020)
- Properties of high dimensional data
- Different distance metrics
- Approximate nearest neighbor search in high dimensions
- Document database search, inverted index
- Vector space model
- TF.IDF for document vector representation
- Document similarity and searching of document databases

Week 3

Lecture 9 (16/09/2020)
- Introduction to temporal databases
- Basic examples requiring support for temporal data elements
- Valid time and transaction time

Lecture 10 (17/09/2020)
- SQL-2011 support for temporal elements
- Time period concept
- Application-time period table and System-time period tables (System versioned tables)
- Creating Application-time period tables
- Insert, update, delete in application-time period tables
- Primary key and foreign key in application-time period tables

Lecture 11+12 (18/09/2020)
- Querying application-time period tables
- Creating system versioned tables
- Insert, update, delete in system-versioned tables
- Primary key and foreign in system-versioned tables
- Querying system-versioned tables
- Support for application-time period tables in Oracle - demonstration
- Support for system versioning in MS SQL Server – demonstration
- Summary and discussion

Week 4

Lecture 13 (23/09/2020)
- Deductive databases
- Basic Datalog concepts
- Facts and rules
- Head, goal and body of rules
- Conjunction and disjunction
- Simple Datalog program

Lecture 14 (24/09/2020)
- Datalog with negation
- RA, TRC, DRC, DL equivalence
- Safe datalog
- Converting safe non-recursive datalog with and without negation to RA

Lecture 15+16 (25/09/2020)
- Class test 1 (topic temporal databases) held
- Recursive Datalog rules
- XSB for writing and executing Datalog programs

Week 5

Lecture 17 (30/09/2020)
- Advanced topics in transaction management
- Review of basic techniques

- ACID properties
- Lock based protocol
- Timestamp-based protocol
- Validation based protocol (Optimistic concurrency control)

Lecture 18 (01/10/2020)
- Multi-level schemes
- Multi-version schemes
- Weak levels of consistency
- Snapshot isolation

Week 6

Lecture 19 (07/10/2020)
- Weak levels of consistency revisited
- Phantom phenomenon
- Serializability considerations for insert and delete operations
- Index locking

Lecture 20 (08/10/2020)
- Long lived transactions and Sagas
- Compensatory transactions
- Recovery mechanisms
- Notion of stable storage
- Log based recovery
- Undo and redo operations

Lecture 21+22 (09/10/2020)
- Distributed databases
- Homogeneous and heterogeneous distributed databases
- Replication and fragmentation
- Data transparency
- Two phase commit
- Failure modes and their handling in 2PC

Week 7

Lecture 23 (14/10/2020)
- Alternative models of transaction processing
- Persistent Messaging
- Concurrency control in distributed transaction processing
- Single and distributed lock manager approaches
- Majority protocol, biased protocol, quorum consensus protocol

Lecture 24 (15/10/2020)

- Timestamping
- Replication with weak concurrency
- Deadlock handling
- Centralized approach
- Global wait for graphs
- False cycles
- Availability in distributed databases

Lecture 25+26 (16/10/2020)
- Class Test 2 held
- Consistency vs. Availability
- CAP Theorem
- BASE property
- Availability vs Latency

Week 8

Lecture 27 (21/10/2020)
- In-memory databases introduction
- Characteristics of in-memory databases
- Design and architectural considerations
- Garcia-Molina's paper

Lecture 28 (22/10/2020)
- Design considerations continued
- H-store – In-memory database (row store)
- C-store – a column data store (not in-memory)

Week 9

Lecture 29 (28/10/2020)
- Motivation behind re-architecting database design
- C-Store continued

Lecture 30 (29/10/2020)
- Join index
- Plattner's paper on both OLTP and OLAP workloads on In-memory databases
- Oracle Times Ten
- Overview of VoltDB, Vertica, MariaDB, MonetDB