(1.) Course Title: INFPHD637 Databases and knowledge bases (complex exam preparatory)	**Credits: 6**
Course **Classification: Mandatory chosen**	
Theoretical or Practical Nature of the Course, *'training character'*[13]: theory-practice ratio 100% (credit%)	
Type of Class: practice and **number of hours**: **2/week** in the given semester, *(If the course is not (only) taught in Hungarian, then **the language**: **English**)* **Additional** (specific**) methods and characteristics**[2] used in delivering the knowledge *(if any)*: -	
Assessment Method (Exam / Midterm Grade / **Other**[3]): practical course mark **Additional** (specific) **methods**[4] applied in knowledge assessment *(if any)*: Continuous mid-year assessment, presentations based on literature review, LMS	
Course Placement in Curriculum (Semester Number): -	
Prerequisites (*if any*): -	

Course Description: **A concise yet informative description of the knowledge** to be acquired.

Notes:
Subjects A) recommended for student completed Advanced Database courses I-II.
Subjects B) recommended for students interested in practical database applications and implementations
A) Theoretical fundamentals of databases
1. The relational model and query languages
1. The relational model
2. Conjunctive queries (rule based, tableau queries, conjunctive calculus, SPC/SPJR Algebra)
3. Adding Negation: Non recursive Datalog, Algebra, relational (domain) calculus, equivalence theorems
4. Query optimization,
5. Query equivalence and containment of tableau queries, undecidability of query equivalence,
6. Acyclic joins
2. Constraints and design theory
7. Functional and Key dependencies; implication, algorithm for deciding implication, Armstrong axioms.
8. Join and multivalued dependencies, decompositions. Axiomatizations: yes for FD and MVD; no for FD and JD.
9. Deciding implication for FD-s and JD-s in common, The Chase algorithm.
10. Inclusion dependencies, implication, axiomatization, complexity of deciding implication. Inclusion dependencies and FD-s: undicadability theorem.
11. Design theory of relational databases, Normal Forms
3. Datalog
12. Recursive, non negated Datalog programs
13.Model-theoretic ,Fixpoint semantics, Proof-theoretic spproach
14.Seminaive evaluation of Datalog, Top-down evaluation techniques
4. Recursion and negation
15.Inflationary and destructive semantics of recursive queries with negation
16.The While and While+ languages for relational algebra

17. Partial fixpoint and fixpoint extension for relational calculus, Negated and double negated Datalog,
18. Equivalence theorem for inflational and noninflational languages
5. Expressiveness and complexity
19.Typed, computable and generic queries
20. Complexity of Queries and Languages
21.Complexity of First-Order Queries
22.Expressiveness of First-Order Queries
23. Fixpoint and While Queries
24.The Impact of Order - PTIME and PSPACE queries
6. Complex Values
25.Complex Value Databases, types, schemas and instances 511
26.The Algebra and the Calculus for complex velues
27 Equivalence Theorems , Expressive Power and Complexity
7. Object Databases
28. Informal presentation and formal definition of an OODB Model
29. Languages for OODB Queries
30.The Object Relational model in SQL 31.XML as data and XML query languages

B) Database Technologies
1. The relational database model, data modelling, Entity-Relationship model, UML, mapping to relational model
2. Design theory of relational databases, functional dependencies, decomposition, implication problem of dependencies, the Chase algorithm, Boyce-Codd Normal Forms, 3NF, multivalued dependencies, 4NF and algorithms for normalization.
3. Operations for relations. Basic relational algebra, extended algebra, sets and multisets . Independent set of operations. Logics on relations, Datalog rules and programs, recursion and minimal fixpoint.
4. The SQL database language. Queries in SQL, mapping between algebra and SQL. The SELECT statement, set operations, subqueries, aggregation and grouping.
5. Data definition in SQL, CREATE, ALTER, DROP statements, modifications of tables: Insert-DeleteUpdate, transactions in SQL
6. Constraints (keys, referential integrity, CHECK constraints, global constraints) and triggers in SQL
7. VIEWS and indexes in SQL
8. Embedded SQL, dynamic SQL, PSM, interfaces
9. Recursion is SQL (WITH option), nested relations, object-relational model
10. XML and XML query languages
11. On-Line Analytic Processing, star schemas, data cubs
12. Relational data organization on secondary storage
13. Index structures, B-trees, hash-tables, multidimensional indexes, bitmap indexes
14. Query execution plans, cost model, one-pass, two-pass algorithms for relational operations, multipass algorithms, index-, hashing- and sort-based algorithms
15. Query compiler, optimization strategies, physical execution plans
16. Coping with system failures, transactions and logging based recoveries (undo, redo), archives
17. Concurrency control, ACID transactions, schedules, serializable schedules, lock-based and timestamp based protocols for enforcing serializability
18. Serializability and recovery, dirty data and cascading roll-back, deadlock, long transactions
19. Transaction management in distributed databases; distributed locks, distributed serializability, commit protocols, recovery and synchronization
20. Distributed query processing, executing full relational operations, distributed joins (semijoins and acyclic joins),
21. Parallel processing (Map-Reduce framework) and pear-to pear serach (distributed hash-tables, Chord-Circles and Finger Tables

2-5 Most Important Required and Recommended Literature

List of required and recommended literature (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

Abiteboul S. –Hull R.– Vianu V.: Foundation of Databases, Addison-Wesley Publ. Comp. 1995.,
Ullman J.D., Widom J. : A First Course in Database Systems, Pearson Prentice Hall, 2008.
Garcia-Molina H., Ullman J.D., Widom J.: Database Systems – The Complete Book, 2nd edition. Pearson Prentice Hall, 2009.

List of Prescribed Professional Competencies and Competency Elements

(knowledge, skills, etc., KKK Section 8) that the course significantly contributes to developing (highlight the most important ones).

a) Knowledge

- Has a research-level understanding of the general and specific characteristics, major directions, and precisely developed boundaries of the subject area within the discipline, as well as the agreed and debated interrelations.
- Creatively comprehends the interrelations, theories, and conceptual frameworks and terminologies of the given field of study.1
- Possesses research methodology knowledge necessary for independent research in the given discipline/field.

b) Skills

- Capable of creative analysis of the field, synthesizing comprehensive and specific interrelations with a new perspective, and conducting appropriate evaluative and critical activities.
- Able to apply and further develop the specialized learning and problem-solving methods of the field.
- Can creatively elaborate on the novel, previously unknown practical implications of theoretical issues.
- Capable of planning and executing new projects, conducting research in the field, and developing new techniques and approaches.
- Able to identify unforeseen professional problems and uncover the detailed theoretical and practical background necessary for their resolution at a research level.
- Can construct and communicate new relations relevant to the field, as well as comprehensive interrelations significant for personal and communal existence.

c) Attitudes

- Represents and further develops the relations that contribute to the process of human self-creation based on the field's characteristics.

[1] **Section 108**, Article 37 of the National Curriculum Act (Nftv.) 37. lesson: a session (lecture, seminar, exercise, consultation) requiring the personal involvement of the instructor to fulfil the academic requirements specified in the curriculum, the duration of which is at least forty-five minutes and not more than sixty minutes.

[2] e.g. case studies, role play, thematic presentations, etc.

[3] e.g. continuous debriefing, mid-year report

[4] e.g. request for case studies, thematic papers, essays, business, organisational plans, etc.

- Possesses an interest and learning ability that enable identifying and solving currently unpredictable research problems in the field.
- Demonstrates a firm professional commitment, a continuous dedication to exploring new approaches, and an acceptance of the necessity for persistent effort.

d) Autonomy and Responsibility

- Builds and initiates new knowledge areas with creative independence and proposes new practical solutions.
- Participates in formulating theoretical and practical questions with a leadership role and high-level cooperation.
- Engages as an equal discussion partner with professionals in the field.
- Takes responsibility for raising and addressing new ethical questions concerning theoretical and practical aspects of the profession.

Course responsible (name, position, academic degree): **Dr. Bálint Molnár, Habil. Associate Professor, PhD**

Instructor(s) involved in teaching the course (if any) (name, position, academic degree): **Dr. Khawla Bouafia, Assistant Professor**