IS 331-101
Database Design, Management and Applications
Course Syllabus, V1.0
(This is a version 1.0 of the Course Syllabus. Note that we always reserve the right to subsequently make changes to the syllabus for the benefit of the class, and these will be announced in Moodle.)

Fall, 2013

Instructor: Dr. Songhua Xu

Office Hours: Suite 5604 GITC, Mon, 5:00pm – 5:50pm or by special appointment

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Class Time: 6:00pm - 9:05pm, Monday

Class Location: Cullimore Hall, 110

Class Period: Sep 03, 2013 - Dec 11, 2013


Course Overview: IS331 introduces students to database design, exemplary database applications, and the need for databases and their utilization as a strategic corporate resource. Topics include (1) data modeling (primarily E-R data modeling), (2) relational database design (including database integrity issues), (3) professional and ethical responsibilities of database professionals, (4) query design in SQL, (5) identifying poorly designed databases and their rectification, (6) optimal design of databases invoking conceptual topics in relational decomposition, functional/multivalued dependencies and normalization (through 3NF, BCNF, 4NF and DKNF), (7) Denormalization and read-only/non-updateable databases, including data warehouses, and (8) Structured Query Language (SQL) and DBMS products such as Oracle and Aqua Data Studio (including Data Studio’s E-R Data Modeler)

Course Description (modified and adapted from Catalog): Businesses use databases extensively for analysis and decision-making because they provide efficient, large-scale information storage and rapid retrieval. Databases support the “back end functionality” of most large web systems. This course gives students extensive, pragmatic experience in designing, building, querying, updating, maintaining and managing relational databases, using the Structured Query Language (SQL). Proper database design principles are emphasized throughout the course, beginning with high level descriptions of relational databases using data modeling tools (such as ER (Entity Relationship) diagrams) and progressing to relational database design principles based on higher order normalizations. We will examine some poorly designed databases and show how these can be transformed into well designed databases. SQL will be extensively covered, and students will design and implement sophisticated SQL queries invoking self-joins, outer joins, correlated subqueries and
related concepts. Students will explore and utilize design methodologies for input data validation and maintaining database integrity, and study related issues of database privacy and security. Advanced topics to be discussed include the role of the Database Administrator (DBA), database life cycle activities, database denormalizations, read-only databases and data warehouses. Hands-on experience will be gained by working with actual databases using industry-standard database management systems such as Oracle.

**Prerequisite:** Completion of a 100-level GUR course in computing, such as IS117 or CS101 or CS104 or CS113. (It is also assumed that students have some basic familiarity with Microsoft Office (2007 or 2010), particularly Microsoft Access.)

**Class Communication Space/Learning Management System:** We will be using Moodle, an open source Learning Management System at NJIT, for the posting of projects and class resources and other class announcements are postings. Students are obligated to log into Moodle frequently, and to keep current.

**Course Goals:** To understand the design and development issues regarding databases. Students will obtain a strong conceptual foundation of the underpinnings of database design, as well as gain experience with some commercial database management products, ranging such as Oracle. IS331 seeks to provide the student with the conceptual and pragmatic aspects and issues related to designing, implementing, managing, deploying and utilizing database applications, with the emphasis on the student’s comprehension of key concepts in database design (as opposed to programming or algorithms). The student will utilizes various DBMS products and software tools, including Oracle and Aqua Data Studio, to put into practice the database concepts presented.

**Lecture Notes:** Presentation slides will be downloadable from Moodle

**Course Grade Components:**

- Midterm Exam (closed book, open notes (no copies of textbook pages), no electronic devices) 30%
- Final Exam (closed book, open notes (no copies of textbook pages), no electronic devices) 30%
- Database conceptual assignments and DBMS projects 40%

**Policy on Collaboration/Cheating:** Every assignment/project is a 'home-mini-exam.' The NJIT Honor Code will be strictly upheld. Students found cheating/collaborating/plagiarizing will be immediately referred to the Dean of Students and the NJIT Committee on Professional Conduct and subject to possible Disciplinary Probation, a permanent marking on the record, possible dismissal and a grade of 'F' in the course. All submitted assignments are carefully checked for similarities, and plagiarism and guilty students will be identified and referred to the Dean of Students for disciplinary action.

**Policy on Lateness of Submission:** Every assignment/project will have a due date/time, and all submissions must be submitted by this due date/time. Assignments submitted after the due date/time will NOT be accepted. NO EXCEPTIONS.

Below are the TOPICs covered in the course and the related TEXTBOOK readings. Remember one of the keys to success in IS331 is your own self-discipline - your goal should be to maintain currency each week, and NEVER fall behind! (Note: this is the topical curriculum model for the course, though we reserve the privilege to modify and adjust attributes of this table (topics, dates, etc.) for the benefit of the course.)

<table>
<thead>
<tr>
<th>Class Meeting #</th>
<th>TOPICS</th>
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<tbody>
<tr>
<td>1</td>
<td>Welcome, Introduction to Database Concepts and</td>
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<tr>
<td>2</td>
<td>High-Level Descriptions of Relational Databases, Using Entity Relationship Data Modeling and E-R Diagrams (utilizing both Chen and Crow’s Foot notational schemes)</td>
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<tr>
<td>3</td>
<td>Querying a Database. The Relational Algebra for Query Design, RA Operators and Querying a Database (using GQBE), Database Joins, Relationship Types, Relational database design, Designing validation rules for database integrity</td>
</tr>
<tr>
<td>4</td>
<td>Using a graphical Interface (GQBE) for design of Database Queries with examples/applications. Responsibilities of the database professional, including database integrity and ethical obligations involving privacy/security of data</td>
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<tr>
<td>5</td>
<td>Designing Intersection Tables for Many-To-Many Relationships, Introduction to the syntax of Structured Query Language (SQL), Introductory SQL query design for single table queries, Group Formation in SQL Queries</td>
</tr>
<tr>
<td>6</td>
<td>Query Design in SQL using multiple tables, SQL implementation of Cartesian products (cross joins) for multi-table queries</td>
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<tr>
<td>7</td>
<td>Examining some poorly designed databases, and the conceptual tools available for Optimal Database Design, including concepts of functional dependencies, Armstrong’s axioms, relational decompositions and lossless joins, and inferring new functional dependencies from existing functional dependencies.</td>
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<tr>
<td>8</td>
<td>Midterm Exam – Attendance Required - Precise Details To Be Announced In Class Lecture on Using Functional Dependencies to Obtain superkeys, primary keys and candidate keys of a database</td>
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<tr>
<td>9</td>
<td>Optimal database design using Database Normalization (1NF, 2NF, 3NF, BCNF), including database decompositions and functional dependencies. Ramifications of poorly designed databases.</td>
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<tr>
<td>10</td>
<td>Advanced Optimal Database Design including topics in multivalued dependencies, 4NF, using DKNF (the highest order normal form) to directly obtain optimal database designs. Database compression and</td>
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Specific Goals for this Course:

a. **Specific outcomes of instruction,** ex. The student will be able to explain the significance of current research about a particular topic.

   1. The student can demonstrate the use of SQL to properly and optimally design and implement a database from a set of user requirements, insuring data integrity, and providing a high level description of the database, using EntityRelationship Data Modeling.
   2. The student will identify poorly designed databases, and redesign them into well-designed databases.
   3. The student is able to construct sophisticated SQL queries, using advanced SQL topics such as self-joins, inner and outer joins, and correlated subqueries.
   4. The student can define the critical responsibilities of a database professional, particularly in regard to privacy of data, security, and integrity.
   5. The student is able to apply the conceptual ideas underlying relational database design, including design concepts such as referential integrity, conforming to higher order normalization designs, functional and multivalued dependencies and relationships.

b. **explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.**

   Student Outcomes a, b, e, h, j are addressed in the course (we generally do not require team projects in IS 331, which is the essence of Outcome d, and we do not base any material on Outcome j, their IS application environment).

**Brief List of Topics to be Covered:**

a. properties of databases
b. flatfile databases vs. relational databases
c. high-level descriptions of databases, using Entity-Relationship Diagrams with standard and IE Crow’s Foot Nomenclature
d. translating ER Models to Relational Designs
e. methodologies for querying a database, including Relational Algebra operators and graphical query
interfaces such as GQBE
f. fundamental syntax of SQL, creating a database with SQL
g. examining some poorly designed databases, and rectifying their design
h. responsibilities of the database professional, including issues of database integrity, ethical obligations involving privacy/security of data
i. functional dependencies and multivalued dependencies
j. optimal database design using Normalization (1NF, 2NF, 3NF, BCNF, 4NF, DKNF)
k. denormalization and when denormalization should be invoked l. updateable vs. read-only databases
m. referential integrity, foreign key constraints and implications, and casual relationships n. data warehouses
o. Aqua Data Studio & Oracle
p. advanced SQL query design, including sophisticated SQL queries using self-joins and inner/outer joins
q. input validation and database integrity r. database redesign
s. correlated subqueries in SQL