Comprehensive Exam Winter 2009 — CS360 (Databases)

**Question 1** (1 points):
Index Structures. The data structure known as $B^+$-tree

(a) is often used to implement a dynamic multilevel index.
(b) stores data pointers only at the leaf nodes of the tree.
(c) ensures that all leaf nodes are at the same level of the tree.
(d) all of the above.

**Question 2** (1 points):
ER-Diagrams. In ER-Diagrams,

(a) the value set (domain of values) of each simple attribute is displayed in ovals.
(b) an entity type is represented as a rectangular box, multivalued attributes are displayed in double ovals.
(c) an entity type is represented as a rectangular box and a relationship type is represented as an oval.
(d) the degree of a relationship type is always two.

**Question 3** (1 points):
In the formal definition of the relational model,

(a) a relation (or relation state) $r \subseteq \text{dom}(A_1) \times \ldots \times \text{dom}(A_n)$
(b) an $n$-tuple $t$ is an ordered list of values $t = (v_1, \ldots, v_n)$ where each $v_i \in \text{dom}(A_i)$, or NULL
(c) the schema of a relation is denoted by $R(A_1, \ldots, A_n)$
(d) all of the above
(e) none of the above
**Question 4** (1 points):

(a) The key constraint
(b) The entity integrity constraint
(c) The domain constraint
(d) The referential integrity constraint

is specified between two relations and is used to maintain the consistency among tuples in the two relations. Informally, it states that a tuple in one relation that refers to another relation must refer to an existing tuple in that relation.

**Question 5** (1 points):
For this question please refer to the COMPANY relational database schema shown in Figure 5.7 at the end of this exam. The relational algebra query

$$\Pi_{\text{Name}, \text{Salary}}(\sigma_{\text{Dname} = \text{Research}}(\text{DEPARTMENT} \bowtie_{\text{Dnumber} = \text{Dno}} \text{EMPLOYEE}))$$

(a) retrieves the department name and the salary of all researchers.
(b) retrieves the last name and the salary of all employees who work for the research department.
(c) is ill-formed and thus not a legal expression in relational algebra.
(d) retrieves the last name and the salary of the manager of the research department.
**Question 6** (1 points):
For this question please refer to the COMPANY relational database schema shown in Figure 5.7 at the end of this exam. The query

Retrieve the first and last names of employees who do not work on any project can be specified in relational algebra as

(a) $\Pi_{\text{Fname}, \text{Lname}}((\Pi_{\text{Ssn}}(\text{EMPLOYEE}) \smallsetminus \Pi_{\text{Essn}}(\text{WORKS-ON})) \times \text{EMPLOYEE})$
(b) $\Pi_{\text{Fname}, \text{Lname}}((\Pi_{\text{Essn}}(\text{WORKS-ON})) \smallsetminus \Pi_{\text{Ssn}}(\text{EMPLOYEE}) \times \text{EMPLOYEE})$
(c) $\Pi_{\text{Fname}, \text{Lname}}((\Pi_{\text{Ssn}}(\text{EMPLOYEE}) \times \Pi_{\text{Essn}}(\text{WORKS-ON})) \times \text{EMPLOYEE})$
(d) $\Pi_{\text{Fname}, \text{Lname}}((\Pi_{\text{Ssn}}(\text{EMPLOYEE}) \div \Pi_{\text{Essn}}(\text{WORKS-ON})) \times \text{EMPLOYEE})$

**Question 7** (1 points):
For this question please refer to the COMPANY relational database schema shown in Figure 5.7 at the end of this exam. The SQL query

```sql
SELECT LNAME, FNAME
FROM EMPLOYEE, WORKS_ON, PROJECT
WHERE DNO=5 AND SSN=ESSN AND PNO=PNUMBER
AND PNAME='ProductX' AND HOURS>10;
```

(a) retrieves the last and first names those employees who are either in department 5 or who work more than 10 hours per week or who work on the ProductX project.
(b) retrieves the last and first names those employees in department 5 who work more than 10 hours per week or who work on the ProductX project (or both).
(c) retrieves the last and first names of all employees in department 5 who work more than 10 hours per week on the ProductX project.
(d) is ill-formed and thus not a legal SQL query.
**Question 8** (1 points):
The JDBC approach to database programming

(a) is an example of embedding database commands in a general-purpose programming language (embedded SQL).

(b) is an example of using a library of database functions made available to the host programming language for database calls (API approach).

(c) is an example of designing a brand-new database programming language from scratch.

(d) all of the above.

(e) none of the above.

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**Question 9** (1 points):
Database Theory. Consider the relation schema $R(A, B, C)$. Let $F = \{A \rightarrow B, A \rightarrow C\}$ be a set of functional dependencies (FDs) on $R$. Which of the following FDs is NOT in $F^+$?

(a) $A \rightarrow B$

(b) $B \rightarrow C$

(c) $AB \rightarrow C$

(d) $A \rightarrow BC$

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**Question 10** (1 points):
Database Theory. Consider the relation schema $R(A, B, C, D, E, G)$. Let the set of FDs on $R$ be $F = \{AB \rightarrow CD, BC \rightarrow ADE, A \rightarrow CE, C \rightarrow AD, E \rightarrow AG, CD \rightarrow G\}$.

(a) $BD$ is a key of $R$.

(b) $R$ is in BCNF.

(c) $R$ is in 3NF.

(d) $R$ has more than one key.
Please feel free to detach this sheet from the exam.

**Figure 5.7**
Referential integrity constraints displayed on the COMPANY relational database schema.

<table>
<thead>
<tr>
<th>EMPLOYEE</th>
<th>DEPARTMENT</th>
<th>DEPT_LOCATIONS</th>
<th>PROJECT</th>
<th>WORKS_ON</th>
<th>DEPENDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fname</td>
<td>Dname</td>
<td>Dnumber</td>
<td>Pname</td>
<td>Essn</td>
<td>Essn</td>
</tr>
<tr>
<td>Minit</td>
<td>Dnumber</td>
<td>Mgr_ssn</td>
<td>Pnumber</td>
<td>Pho</td>
<td>Dependent_name</td>
</tr>
<tr>
<td>Lname</td>
<td>Mgr_ssn</td>
<td>Mgr_start_date</td>
<td>Plocation</td>
<td>Hours</td>
<td>Sex</td>
</tr>
<tr>
<td>Ssn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bdate</td>
</tr>
<tr>
<td>Bdate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Relationship</td>
</tr>
</tbody>
</table>