Part 1: Multiple Choice (93 points - 3 points per question)

(B) 1. Which is an entity in a museum?
   (A) Open hours (B) Exhibition items (C) Ticket price (D) none of the above

(D) 2. Which is true?
   (A) Database system is a collection of related data.
   (B) Metadata is the state of data.
   (C) Database schema changes every time the database is updated.
   (D) None of the above

(A) 3. Which is not a database modification operation? (A) Query (B) Insertion (C) Deletion (D) Update

(B) 4. Which is a job of a DBA?
   (A) Defining the database constraints (B) Authorizing access to the database
   (C) Defining the database transactions (D) None of the above

(C) 5. Which is true?
   (A) Database schema refers to the content of a database at a moment in time. (B) Schema is also called extension.
   (C) Potential for enforcing standards is an implication of using database approach. (D) None of the above

(B) 6. In the three-tier client-server architecture, which tier is for application server?
   (A) Web browser (B) Web server (C) database system (D) None of the above

(C) 7. Which is in the DBMS-dependent design process?
   (A) Requirement analysis (B) Conceptual design (C) Transaction implementation (D) None of the above

(C) 8. In the following figure, which attribute is multivalued?
   (A) Years Employed (B) Address (C) Skill (D) none of the above

(A) 9. Which is usually to represent a relationship in an ER diagram? (A) verb (B) noun (C) adjective (D) proposition

(D) 10. An entity whose existence depends on another entity is called:
   (A) codependent entity (B) variant entity (C) strong entity (D) weak entity

(A) 11. The _____ of a relationship type is the number of participating entity instances.
   (A) cardinality (B) degree (C) identification (D) participation

(D) 12. Which is true?
   (A) A relationship type is the current state of a relationship.
   (B) A relationship instance identifies certain relationship constraints.
   (C) A relationship cannot have more than one attribute.
   (D) none of the above

(A) 13. Which type of relationships between an auction item and a bid?
   (A) one-to-many (B) many-to-many (C) many-to-one (D) one-to-one

(C) 14. Which of the following is false?
   (A) The EER is a type of conceptual data models.
   (B) E. F. Codd first proposed the relation model.
   (C) An entity can exist in the database merely by being a member of a subclass.
   (D) None of the above

(B) 15. Which rule states that an entity instance can simultaneously be a member of two (or more) subtypes
   (A) partial specialization (B) overlap (C) disjoint (D) total specialization

(B) 16. Which of the following is false?
   (A) A relation can have multiple candidate keys.
   (B) Key constraint means the primary key cannot have null values.
   (C) A candidate key can uniquely identify a row.
   (D) An enterprise key whose value is unique across all relations.

(A) 17. Which is a type of semi-structured data? (A) XML (B) text (C) images (D) video

(C) 18. Which is persistent data? (A) SQL statements (B) work queues (C) HTML documents (D) none of above

(A) 19. Which constraint may the delete operation violate?
   (A) Referential constraint (B) Entity constraint (C) Key integrity (D) None of the above
(C) 20. In the following EER diagram, which is true?

(A) An account can be a checking and savings account.
(B) An account type is determined by Account_no.
(C) There is no account that does not belong to checking, savings, or loan accounts.
(D) None of the above

(B) 21. Which of the following finds those groups meeting stated conditions?
(A) group by (B) having (C) using by (D) none of the above

(B) 22. Which is an approach to map a n-ary relationship type in the ER diagram to the relational schema?
(A) Merged relation (B) A relationship relation and n foreign keys (C) A relation set of simple component attributes (D) None of the above

(C) 23. To eliminate duplicate rows in a query, which can be used?
(A) unique (B) index (C) distinct (D) none of the above

(D) 24. Which integrity constraints can trigger a sequence of operations?
(A) restrict (B) set default (C) set null (D) cascade

(A) 25. Which is a join condition in the following SQL commands?
```sql
select name from employee, department
where department_name = 'Research' and employee.department_no = department.department_no;
```
(A) employee.department_no = department.department_no (B) department_name = 'Research'
(C) select name from employee, department (D) None of the above

(D) 26. In the like operator of SQL, which can represent any string? (A) * (B) ; (C) _ (D) %

(D) 27. In MySQL which command can show the schema of a table? (A) show (B) display (C) present (D) describe

(C) 28. When you log into your Yahoo account, which SQL command will be used?
(A) insert (B) update (C) select (D) delete

(A) 29. Which is a benefit of denormalization?
(A) performance improvement (B) higher security (C) less storage (D) none of the above

(A) 30. What does the following SQL statement do? select name from student where city = 'Hsinchu';
(A) Retrieves the name of all students who live in Hsinchu.
(B) Retrieves all students who live in Hsinchu from the student table.
(C) Retrieves all cities whose name is Hsinchu from the student table.
(D) None of the above

(D) 31. A rule that database users should obey is called a: (A) regulation. (B) principle. (C) privilege. (D) constraint.

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Part 2: Questions and Answers (124 points)

1. (16 points) Briefly explain these terminologies. If they are acronyms, also write what they stand for.

(a) referential integrity (b) functional dependency (c) identifying relationship (d) XML (e) data mining

(a) The referential integrity constraints indicate any attribute of a foreign key in a table can contain only either values from the corresponding main table’s primary key or the null value.
(b) Functional dependency specifies that the value of an attribute in a table determine the value of other attribute in the same table.
(c) An identifying relationship is the relationship between a weak entity type and its owner.
(d) EXtensible Markup Language (XML) is a language used to specify the data content.
(e) The data mining can be defined in either one as shown in below:
   - The discovery of new information in terms of patterns or rules from vast amounts of data.
   - The process of finding interesting structure in data.
   - The process of employing one or more computer learning techniques to automatically analyze and extract knowledge from data.
2. (a) (4 points) What is data model?
(b) (6 points) Describe the three-schema architecture of databases.
(c) (4 points) Explain the differences between an entity (instance) and an entity type.
(a) A set of concepts to describe the structure of a database, the operations for manipulating these structures, and certain constraints that the database should obey.
(b) In the three-schema architecture, schemas can be defined at three levels: internal schema, conceptual schema, and external schemas.
(c) An entity (instance) is a specific object or thing in the mini-world that are represented in the database. An entity type is a collection of entities that share common properties or characteristics.

3. (a) (4 points) What does SQL stand for? Explain it.
(b) (6 points) Based on the functions how can SQL be classified into three categories?
(a) Structured Query Language (SQL) is a standard language used to retrieve, update and delete data from relational database management systems (DBMS).
(b) Data Definition Language (DDL) is used to define databases.
   Data Manipulation Language (DML) is used to manipulate databases.
   Data Control Language (DCL) is used to control databases.

4. (8 points) A artist relation has 4 attributes: artist_id, name, email, and company. No two artists have the same artist_id and email.
(a) (6 points) List candidate keys and primary key for the artist relation.
(b) (2 points) Explain the reason of choosing the primary key.
(a) candidate keys: artist_id, email
   primary key: artist_id
(b) The artist_id is chosen because it can uniquely identify each tuple in the artist relation and the email might have the null value.

5. (a) (3 points) Explain normalization for a relational database.
(b) (9 points) Explain the 1NF, 2NF, and 3NF.
(a) The process of structuring relations by decomposing their attributes into smaller relations.
(b) i. 1NF is the relation that has no composite attributes, multivalued attributes, and nested relations.
   ii. In 2NF, every non-prime attribute is fully functionally dependent on the primary key in the relation.
      Other possible answers:
      There are no two keys in the relation.
      There is no partial functional dependency in the relation.
   iii. Third normal form (3NF) is a normal form in which there is no transitive functional dependency in the relation.

6. (24 points) Consider the following music store database:

<table>
<thead>
<tr>
<th>Employee Table</th>
<th>Works_On Table</th>
<th>Department Table</th>
<th>Project Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>employee_no</td>
<td>employee_no</td>
<td>department_no</td>
<td>project_no</td>
</tr>
<tr>
<td>name</td>
<td>name</td>
<td>position</td>
<td>title</td>
</tr>
<tr>
<td>E95022</td>
<td>Norah Jones</td>
<td>manager</td>
<td>World Peace</td>
</tr>
<tr>
<td>E95145</td>
<td>Avril Lavigne</td>
<td>clerk</td>
<td>Save the Earth</td>
</tr>
<tr>
<td>E95262</td>
<td>Amy Winehouse</td>
<td>secretary</td>
<td>Save the Children</td>
</tr>
<tr>
<td>department_no</td>
<td>project_no</td>
<td>manager_no</td>
<td></td>
</tr>
<tr>
<td>MK1234</td>
<td>E95022</td>
<td>E95145</td>
<td>P101</td>
</tr>
<tr>
<td>SL2638</td>
<td>E90123</td>
<td>E95262</td>
<td>P311</td>
</tr>
<tr>
<td>HR6324</td>
<td>E88234</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

where primary keys are underlined. department_no in the employee table is a foreign key referencing to the department table. employee_no and project_no in the works_on table are foreign keys referencing to the employee and project table respectively.

(a) If the following operations are taken, check if domain constraints, key constraints, entity integrity, or referential integrity is violated. If there is any violation, explain it.
   i. (2 points) Insert ('E95262', 'Lisa Loeb', 'Sales', MU2348) into the employee table.
   ii. (2 points) Change the project_no of 'PJ202' in the works_on table from 'PJ202' to 'PJ212'.
(b) Use SQL to answer the following questions.

i. (3 points) Create the employee table with the required constraints.

ii. (3 points) Add a constraint of $0 \leq \text{hour} \leq 40$ in the works_on table.

iii. (2 points) Insert ('MU2348', 'Music', E92202) into the department table.

iv. (3 points) For each project, list the project name and the total hours per week (by all employees) spent on that project.

v. (2 points) Change the position of Avril Lavigne from 'clerk' to 'staff'.

vi. (3 points) Remove all projects Norah Jones works on.

(a) i. It violates the key constraint because the employee_no 'E95262' already existed.

ii. It violates the referential integrity because the foreign key, works_on 'PJ212' in the class table will have no primary key to reference to in the project table.

iii. It violates the referential integrity because the foreign key, department_no 'SL2638' in the employee table will have no primary key to reference to in the department table.

iv. It violates no constraint.

(b) i. create table employee (
  employee_no char(6) primary key not null,
  name varchar(30),
  position varchar(15),
  department_no char(6));

ii. alter table works_on add constraint hour
    constraint check (0 <= hour and hour <= 40)

iii. insert into department values ('MU2348', 'Music', E92202)

iv. select pname, sum(hours) from project, works
    on where pnumber = pno group by pnumber, pname

v. update employee set position = 'staff' where name = 'Avril Lavigne'

vi. delete from project where employee_no =
    (select employee_no from employee, works
     on where project.project_no = works_on.project_no and name = 'Norah Jones')

7. (20 points) Consider a Store Franchise Enterprise:

- Each franchise has a name, an address for its corporate headquarters, and the name of its chief executive officer.
- Each store is associated with exactly one franchise and is uniquely identified by its store id and further characterized by its address and phone number.
- The stores maintained in the enterprise can be categorized as supermarkets, pharmacies, gas stations, department stores, warehouse clubs, or a combination of them.
- Note that not all stores associated with the same franchise are of the same type. For example, some stores that are supermarkets may also have an in-store pharmacy. Other stores may also have gas stations. Some stores are a combination of a supermarket and a department store.

(a) (10 points) Please draw a EER diagram for the above Store Franchise Enterprise.

(b) (10 points) Please transform the above EER diagrams to 3NF relations and show the 3NF relation schema.

(a)
(b) supermarket: 
<table>
<thead>
<tr>
<th>store_id</th>
<th>market_id</th>
<th>franchise</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>franchise_name</td>
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<tr>
<td></td>
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</tbody>
</table>
store: 
<table>
<thead>
<tr>
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<th>address</th>
<th>phone_no</th>
<th>franchise_name</th>
</tr>
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<tbody>
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<td></td>
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</tbody>
</table>
pharmacy: 
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<tr>
<th>store_id</th>
<th>licence_id</th>
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<tbody>
<tr>
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</tbody>
</table>
gas station: 
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<thead>
<tr>
<th>store_id</th>
<th>permit_id</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

8. (20 points) Normalize the following tables of data to 3NF relations and show the relation schema.

```
<table>
<thead>
<tr>
<th>student_id</th>
<th>lastname</th>
<th>firstname</th>
<th>gender</th>
<th>depart_id</th>
<th>department</th>
<th>phone_no</th>
<th>address</th>
</tr>
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<tbody>
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<td>2006120034</td>
<td>Avril</td>
<td>Lavigne</td>
<td>female</td>
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<td>Mathematics</td>
<td>03-5272682</td>
<td>123 Main St, Hsinchu 300</td>
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<tr>
<td>2006120034</td>
<td>Avril</td>
<td>Lavigne</td>
<td>female</td>
<td>001</td>
<td>Mathematics</td>
<td>03-5272682</td>
<td>123 Main St, Hsinchu 300</td>
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<tr>
<td>2006202002</td>
<td>Alanis</td>
<td>Morissette</td>
<td>female</td>
<td>002</td>
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<td>220 Happy Rd, Hsinchu 300</td>
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<td>2008-2-3</td>
<td>2008-6-30</td>
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