Part 1: Multiple Choice (90 points - 3 points per question)

(A) 1. Which of the following is not a property of relations?
   (A) Every attribute value must be unique. (B) Each table must have a unique name.
   (C) The order of the rows must be irrelevant. (D) Every attribute value must be atomic.

(B) 2. Which is not an option for the update operation to ensure the referential integrity?
   (A) cascade (B) set constraint (C) set null (D) set default

(B) 3. 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) 4. An identifier that enables a dependent relation to refer to its parent relation is called a:
   (A) unique key (B) candidate key (C) foreign key (D) none of the above

(A) 5. A domain definition consists of the following components except:
   (A) integrity constraints. (B) size. (C) data type. (D) domain name.

(D) 6. Referring to the following figure, which following statement is true?

(A) Child is a strong entity. (B) An employee can have only one child.
   (C) Employee ID in Employee is a foreign key. (D) none of the above

(A) 7. Which of the following statement is true?
   (A) Each non-key is functionally dependent on every candidate key. (B) Each primary key must be atomic.
   (C) Each table can have only one candidate key. (D) none of the above

(D) 8. Which integrity constraints can trigger a sequence of operations?
   (A) set constraint (B) set default (C) trigger (D) none of the above

(A) 9. Which is a benefit of denormalization?
   (A) performance improvement (B) higher security (C) less storage (D) none of the above

(D) 10. Which is a SQL DDL command? (A) delete (B) grant (C) update (D) none of the above

(B) 11. Which SQL command is used to remove a table?
   (A) delete table (B) drop table (C) truncate table (D) none of the above

(B) 12. Which is used to indicate categorization of results in SQL? (A) order by (B) group by (C) sort by (D) having

(C) 13. Which can speed up access to database tables?
   (A) data dictionary (B) data view (C) index (D) none of the above

(A) 14. Which SQL aggregate function returns the number of rows? integrity in SQL?
   (A) count() (B) number() (C) sum() (D) none of the above

(C) 15. Which is an advantage of partitioning a table?
   (A) consistent access speed (B) reducing complexity (C) load balancing (D) none of the above

(A) 16. 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

(C) 17. To eliminate duplicate rows in a query, which qualifier can be used in the SQL Select command?
   (A) unique (B) check (C) distinct (D) specific

(D) 18. What result set will the following query return? select ticker from stock where price < 20;
   (A) The stocks of tickers whose price is less than 20.
   (B) The tickers of stocks whose price is less than 20.
   (C) The prices of stocks whose price is less than 20.
   (D) None of the above

(A) 19. Which of the following represents all attributes of a table in a SQL statement?
   (A) * (B) <> (C) = (D) &
20. Which of the following is true?
   (A) The SQL insert operation will not violate domain constraint.
   (B) The SQL update operation will not violate entity integrity constraint.
   (C) The SQL delete operation can remove a table from the database.
   (D) None of the above

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

22. When you log into your Yahoo account? Which database operation will be involved?
   (A) insert (B) select (C) delete (D) none of the above

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

24. Which SQL command can be used to change a table definition?
   (A) alter table (B) change table (C) modify table (D) none of the above

25. In which type of file is multiple key retrieval not possible? (A) indexed (B) clustered (C) sequential (D) hashed

26. Which of the following can produce scalar and vector aggregates? (A) order by (B) having (C) group by (D) sort

27. Which SQL operator allows you to compare strings using wildcards? (A) like (B) as (C) in (D) none of the above

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

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

30. What result will the following SQL statement produce? select avg(standard_price) as average from product;
   (A) The average price of all products (B) The average of all products in product
   (C) The average standard_price of all products in product (D) none of the above

Part 2: Questions and Answers (98 points)

1. (a) (3 points) What is integrity constraint?
   (b) (8 points) Explain the key constraint, domain constraint, entity integrity constraint, and referential constraint.

   (a) Integrity constraints are the constraints used to ensure accuracy and consistency of data in a relational database.
   (b) • The key constraint means there is no duplicate key in any relation.
        • The domain constraint indicates every value in a tuple must be from the domain of its attribute.
        • The entity integrity indicates the values of primary key attributes in a relation cannot be null.
        • The referential integrity constraints indicate any attribute of a foreign key in a table can contain only either values from the corresponding parent table’s primary key or the null value.

2. (a) (6 points) Describe three types of anomalies that can arise in a table.
   (b) (3 points) What is denormalization?

   (a) • An insertion anomaly is an anomaly in which adding new rows forces user to create duplicate data.
        • A deletion anomaly is an anomaly in which deleting rows may cause a loss of data that would be needed for other future rows.
        • A modification anomaly is an anomaly in which changing data in a row forces changes to other rows because of duplication.
   (b) The process of transforming normalized relations into unnormalized physical record specifications.

3. (a) (2 points) What is functional dependency?
   (b) (2 points) What is a determinant?
   (c) (6 points) Explain 1NF, 2NF, and 3NF.

   (a) Functional dependency specifies that the value of one attribute (the determinant) determines the value of another attribute in the same table.
   (b) A determinant is an attribute that determines the value of another attribute.
   (c) 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.

4. (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.

5. (26 points) Consider the following music store database:

<table>
<thead>
<tr>
<th>employee table</th>
<th>works_on table</th>
<th>project table</th>
</tr>
</thead>
<tbody>
<tr>
<td>employee_no</td>
<td>name</td>
<td>position</td>
</tr>
<tr>
<td>E95022</td>
<td>Norah Jones</td>
<td>manager</td>
</tr>
<tr>
<td>E95145</td>
<td>Avril Lavigne</td>
<td>clerk</td>
</tr>
<tr>
<td>E95262</td>
<td>Taylor Swift</td>
<td>secretary</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'.
iii. (2 points) Remove the row ('SL2638', 'Sales', 'E95022') from the department table.
iv. (2 points) Change the student_no value in the class table from 'B94262'to 'B94623'.
v. (2 points) Change the project name in the project table from 'World Peace' to 'Stop Violence'.

(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 ≤ hour ≤ 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 primay 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 primay key to reference to in the department table.
iv. There is no class table in this case.
v. It violates no constraint.

(b) 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 primay 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 primay key to reference to in the department table.
iv. There is no class table in this case.

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')
6. (14 points) Consider the following relations for a database that keeps track of business trips of salespersons in a sales office.

salesperson(id_no, name, start_year, department_no)
trip(id_no, from_city, departure_date, return_date, trip_id)
expense(trip_id, account_no, amount)

(a) (6 points) Please draw the ER diagram.
(b) (8 points) Please draw the relational schema diagram and indicate the primary keys and the referential constraints.

(a)

(b) salesperson: id_no name department_no start_year

trip: id_no trip_id from_city departure_date return_date

expense: trip_id account_no amount

7. (18 points) Consider the following table.

<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>
</thead>
<tbody>
<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>
</tr>
<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>
</tr>
<tr>
<td>2006202002</td>
<td>Alanis</td>
<td>Morissette</td>
<td>female</td>
<td>002</td>
<td>Philosophy</td>
<td>03-5223412</td>
<td>220 Happy Rd, Hsinchu 300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>isbn</th>
<th>booktitle</th>
<th>author</th>
<th>publisher</th>
<th>purchase_date</th>
<th>checkout</th>
<th>checkout_date</th>
<th>return_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0130428981</td>
<td>Advanced Database</td>
<td>S. W. Dietrich</td>
<td>Prentice</td>
<td>2006-1-20</td>
<td>Y</td>
<td>2008-2-3</td>
<td>2008-6-30</td>
</tr>
<tr>
<td>0316172324</td>
<td>Blink</td>
<td>M. Gladwell</td>
<td>Little</td>
<td>2004-2-3</td>
<td>Y</td>
<td>2008-5-1</td>
<td>2008-6-1</td>
</tr>
</tbody>
</table>

(a) (4 points) Which normalization form of the relation belongs to? Explain.
(b) (8 points) Normalize the following tables of data to 3NF relations and show the relation schema after normalization.
(c) (6 points) Draw the functional dependency diagram after normalization.

(a) It is the first normal form because there are more than one keys that can determine values of other attributes.
(b)  

department: depart_id department

student: student_id lastname firstname gender depart_id phone_no address

checkout: student_id isbn checkout checkout_date return_date

book: isbn booktitle author publisher purchase_date