Part 1: Multiple Choice (75 points - 3 points per question)

1. Which is an entity in a bank?
   (A) Bank’s name (B) Bank’s customer (C) Bank’s address (D) None of the above

2. Which is false?
   (A) Database is a collection of related data.
   (B) Meta-data is the data about data.
   (C) Database state changes every time the database is updated.
   (D) Data query is a database modification operation.

3. Which is not a function of a DBMS?
   (A) database definition (B) database construction (C) data abstraction (D) database manipulation

4. Which is not a job of a DBA?
   (A) Defining the database constraints (B) Authorizing access to the database
   (C) Acquiring software and hardware resources (D) Tuning the DBMS performance

5. Which is false?
   (A) A valid state is a state that satisfies the structure and constraints of the database.
   (B) Database schema refers to the content of a database at a moment.
   (C) Schema is also called intension.
   (D) The database state changes very frequently.

6. _______ specifies some restrictions on valid data.
   (A) Constructs (B) Validity (C) Cardinality ratio (D) None of the above

7. Which is used to specify database retrievals and updates?
   (A) DDL (B) DML (C) DQL (D) None of the above

8. Which is the description of a database?
   (A) Database schema (B) Schema diagram (C) Schema construct (D) Database state

9. Which is used to define the a database schema?
   (A) DDL (B) DML (C) DQL (D) None of the above

10. What is a type of data models? (A) Star (B) Bus (C) Hierarchical (D) None of above

11. Which is in DBMS-dependent design process?
    (A) Requirement analysis (B) Conceptual design (C) Application program design (D) None of the above

12. Which stores the business logic part of the application?
    (A) client (B) application server (C) database server (D) interface

13. An attribute that can be broken down into smaller parts is called a(n) _______ attribute.
    (A) simple (B) associative (C) derived (D) composite

14. The _______ of a relationship type is the number of participating entity types.
    (A) cardinality (B) identification (C) degree (D) participation

15. Which is true?
    (A) A relationship set is the schema description of a relationship.
    (B) The relationship instance is the current state of a relationship type.
    (C) A relationship can have only one attribute.
    (D) None of the above

16. A donor can donate any number of items. The same item can be donated by different donors. The relationship of donor to item is a _______ relationship.
    (A) one-to-many (B) many-to-many (C) many-to-one (D) one-to-one

17. Which of the following is true?
    (A) The EER is a type of conceptual data models.
    (B) An entity can exist in the database merely by being a member of a subclass.
    (C) It is not necessary that every entity in a superclass be a member of some subclass.
    (D) None of the above

18. Which is the process of defining a set of subclasses of a superclass?
    (A) Specialization (B) Generalization (C) Aggregation (D) Identification

19. The property by which subclass entities possess all attributes of a superclass is called attribute:
    (A) aggregation (B) adaptation (C) identification (D) inheritance

20. The relational model is a type of _______ data models.
    (A) conceptual (B) physical (C) implementation (D) hierarchical

21. Which of the following is false?
    (A) A relation can have multiple keys. (B) Any set of attributes that includes a key is a superkey.
    (C) A superkey is a minimal key. (D) The key that is generated by the DBMS is called surrogate key.
22. In the following EER diagram, which is true?
(A) A person can be a camper and a runner.
(B) A person must be a camper, a biker, and a runner.
(C) A person must be a camper, a biker, or a runner.
(D) None of the above

23. In the following EER diagram, which is true?
(A) An owner must be a bank, a person, and a company.
(B) An owner need not be either one of a bank, a person, and a company.
(C) An owner is the union of a bank, a person, and a company.
(D) None of the above

24. Which of the following is false?
(A) E. F. Codd first proposed the relation model.
(B) A relation looks like a table of attributes.
(C) A relation typically contains a set of tuples.
(D) The relation model is derived from the set theory.

25. Which of the following is true?
(A) In a relation each row has a row header called an attribute.
(B) The relation schema is a subset of the Cartesian product of the domains of its attributes.
(C) The tuples are considered to be ordered.
(D) None of the above

Part 2: Questions and Answers (85 points)

1. (20 points) Briefly explain these terminologies. If they are acronyms, also write what they stand for.
(a) data independence (b) UML (c) weak entity (d) ontology (e) functional dependency

2. (a) Data independence is the capacity to change the lower-level schema without having to change the higher-level schema.
(b) Unified Modeling Language (UML) is an object modeling and specification language used in software engineering.
(c) A weak entity is an entity type whose existence depends on another entity.
(d) Ontology means using conceptual modeling and other tools to develop "a specification of a conceptualization".
(e) Functional dependency specifies that the value of an attribute in a table determine the value of other attributes in the same table.

(a) (4 points) What is data model?
(b) (3 points) Name the three-schema architecture.
(c) (2 points) Why do we need mappings between schema levels?

(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) We need mappings to achieve data independence.

3. (12 points)
(a) (6 points) Explain the differences among an entity, an entity type, and an entity set.

(b) (6 points) Describe the two alternatives for specifying structural constraints on relationship types.

(a) • An entity is a specific object or thing in the mini-world that are represented in the database.
• An entity type is a collection of all entities that share common properties or characteristics.
• An entity set is the collection of entities in the database.

(b) • Entity-to-Entity constraint:
  – Cardinality ratios - 1:1, 1:N, N:1, or M:N for binary relationships
  – Participation constraints - total or partial
• Entity-to-Relationship constraint specifies minimum and maximum numbers (min, max) on the participation of each entity type in a relationship type.

4. (8 points) A doctor relation has 4 attributes: doctor_id, name, email, and speciality. No two doctors have the same doctor_id and email.

(a) (6 points) List keys, 3 superkeys, and primary key for the doctor relation.

(b) (2 points) Explain the reason of choosing the primary key.

(a) • keys: doctor_id, email
• superkeys: (any three of the following) doctor_id, email, (doctor_id, name), (doctor_id, email), (doctor_id, speciality), (name, email), (email, speciality), (doctor_id, name, email), (doctor_id, name, speciality), (doctor_id, email, speciality), (name, email, speciality), (doctor_id, name, email, speciality)
• doctor_id

(b) The doctor_id is chosen because it can uniquely identify each tuple in the doctor relation and the email might have the null value.

5. (a) (5 points) Explain the entity and referential integrity constraints in the relational model.

(b) (8 points) Briefly explain the four constraints on specialization and generalization.

(c) (2 points) What is difference between a shared class and a category?

(a) • 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.

(b) • The disjointness constraint specifies that the subclasses of the specialization must be disjoint.
• The overlapping specialization specifies that the subclasses of the specialization can be overlapping.
• The total specialization specifies that every entity in the superclass must be a member of some subclass.
• The partial specialization specifies that an entity in the superclass is allowed not to belong to any of the subclasses.

(c) A shared class is the intersection of the superclasses while a category is the union of the superclasses.

6. (7 points) Draw an EER diagram for the following bank.

A bank has three types of accounts: checking, savings, and loan. The attributes of each account are shown as follows:

Checking: Account_No, Date_Opened, Balance, Service_Charge
Savings: Account_No, Date_Opened, Balance, Interest_Rate
Loan: Account_No, Date_Opened, Balance, Interest_Rate, Payment

Account_type is used to identify the type of accounts.
Assume the account in the bank can be only one of its subclasses.
7. (14 points) The database of a library which can store the information of members, borrow, and books. The database schema of the library is shown as follows:

member (member_no, name, address, phone, email)
borrow (isbn, checkout_date, member_no, borrow_period)
book (isbn, book_title, authors)

(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) [ER diagram]

(b) member: | member_no | name | address | phone | email |

borrow: | isbn | member_no | checkout_date | borrow_period |

book: | isbn | book_title | authors |