You have **100** minutes to complete the exam. Please read the entire exam before starting on it. It would be a good idea to think carefully about each problem before answering. Please be sure to write your name, UFID and email address legibly below. Relax and good luck. Please keep in mind the code number below that has been assigned to you for future reference (mainly for anonymous publication of exam results and grades). **Please only use the stapled paper sheets of the exam. Note that it is not allowed to remove the staples.**

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Pledge (Must be signed according to UF Honor Code)

On my honor, I have neither given nor received unauthorized aid in doing this assignment.

_______________________________________________ Signature

**For scoring use only:**

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<tr>
<td>Exercise 1</td>
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Exercise 1 (Knowledge Questions) [30 points]

(a) By using mathematical notation and a brief description of what the notation means, explain the following notions precisely (Do not use examples!):

1. Alternative definition of relation. (6 points)

2. Tuple. (6 points)

3. Union operation on relations. (6 points)

(b) Define briefly in complete sentences and in your own words the following concepts:

5. What are multivalued attributes? (6 points)

6. Show by example using E-R diagrams (6 points)
   1. Binary relationship set with one entity set.
   2. Ternary relationship set.
**Exercise 2 (ER Model) [30 points]**

Provide an ER Diagram that describes the following requirements for a Online Auction System:

- There are two types of users: Bidders and Sellers
- Both types of users exist as users (identified by a username) that represent individuals.
- One individual can exist as both bidder and seller.
- Items to be auctioned are categorized
- Auctions can have a reserve price and an item can be auctioned more than once either by a different user or if the reserve price in previous auctions was not met.
- Regular bids are entered by bidders before auction close time.
- Proxy bids are automatically incrementing bids that define a maximum amount, a starting amount and an increment over the max bid so that the amount can automatically be updated whenever a higher bid is entered. Every time a higher bid is entered the system parses through the proxy bids and enters regular bids depending on the proxy bids found for that item.
- Besides the standard contact information (ph#, email), individuals have addresses for billing, shipping and residence information, each of which might be different from each other.
- Bidders and sellers can provide reviews of other individuals only if they have been related through any auction. Reviews include a score (min 0, max 5) and detailed comments from the individual that inputs the review plus a response from the individual who is targeted by the review.
Exercise 3 (Other ER related) [20 points]

Consider the ER diagram shown below for part of a BANK database.

(a) Transform the following Entity-Relationship Diagram into a corresponding relational schema. You need not include data types in the schema.(10 points)
(b) Is there any weak entity type? If so, give its name(s), partial key and identifying relationship. (5 points)

(c) Suppose that every customer must have at least one account but is restricted to at most two loans at a time, and that a bank branch cannot have more than 1000 loans. How does this show up on the (min, max) constraints? Write the answer in this form, i.e. $[\text{Relationship } \rightarrow \text{Entity1 (min, max)}, \text{Entity2 (min, max)}]$ (5 points)
Exercise 4 (Relational Algebra) [5x4 = 20 points]

Given the following relational schema:

PERSON(PersonID, Initials, LastName, DOB, Sex)
DOCTOR(PersonID, RoomNo, PhoneNo, DateQualified, DateAppointed)
PATIENT(PersonID, DateRegistered, RegisteredWith)
APPOINTMENT(DoctorID, PatientID, Date, Time, Duration)
TREATMENT(DoctorID, PatientID, Condition, Treatment, Start, End)

and the following queries in natural language:

1. Retrieve PersonID and PhoneNo from all DOCTORs.

2. Retrieve PersonID and LastName from all those PERSONs whose LastName is ‘Jackson’.

3. Retrieve PatientID of the patients who have APPOINTMENTs with the doctor(s), however, do not have any TREATMENTs prescribed by the doctor(s).

4. Retrieve PatientID of the patients who have both APPOINTMENTs with the doctor(s) and TREATMENTs prescribed by the doctor(s).

State all four queries using relational algebra base on the given relational schema.