Name: _____

CSCI 403 - Database Management
Midterm Exam

October 26, 2015

Instructions:

This exam has 6 pages, make sure you have them all. The last page may be detached for easier reference, if desired.

There are 20 multiple choice questions below, worth 5 points each. Circle **one** answer for each question.

Questions:

These questions concern the air travel database relational schema shown in figure 1.

1. Which constraint would be violated if we inserted the tuple ('Knuth, Donald', 111222333) into the `customer` relation?

   (a) Primary key on the `customer` relation.

   (b) Primary key on the `airline_customer` relation.

   (c) Foreign key on the `airline_customer` relation referencing `customer(name)`.

   (d) No constraints would be violated.

2. Which constraint would be violated if we updated the tuple (1337, 'Delta', 3333) in the `trip_flight` relation to be (1337, 'Delta', 2222)?

   (a) Primary key on the `trip_flight` relation.

   (b) Primary key on the `flight` relation.

   (c) Foreign key on the `trip_flight` relation referencing `flight(airline, flight_no)`.

   (d) No constraints would be violated.

3. Which constraints on the `airline_customer` relation would be violated if we inserted the tuple ('American', NULL, NULL) into it?

   (a) Primary key.

   (b) Primary and both foreign keys.

   (c) Primary key and foreign key referencing `customer(name)`.

   (d) No constraints would be violated.

4. In general, what kind of constraints can we violate by deleting a tuple?

   (a) Primary keys only.

   (b) Foreign keys only.

   (c) Both primary and foreign keys.

5. Which of these relational algebra expressions is valid?

   (a) $\pi_{airline,dep\_time,arr\_time,fare}(\sigma_{dep\_airport='CHI'}(flight))$

   (b) $\sigma_{dep\_airport='CHI'}(\pi_{airline,dep\_time,arr\_time,fare}(flight))$

   (c) Both (a) and (b).

   (d) None of the above.

6. How many tuples (based just on the sample data provided) would be returned by the expression $\pi_{airline,trip\_id}(trip\_flight)$?

   (a) 0

   (b) 2

   (c) 4

   (d) 6

7. Which of these relational algebra expressions is equivalent to $\pi_{website}(airline \bowtie_{name=airline} (\sigma_{arr\_airport='DEN'}(flight)))$?

   (a) $\pi_{website}(\sigma_{arr\_airport='DEN'}(airline * flight))$

   (b) $\pi_{website}(\sigma_{(arr\_airport='DEN' \text{ AND } name=airline)}(airline \times flight))$

   (c) Both (a) and (b).

   (d) None of the above.

8. Which best describes the output of the SQL query below?

```
SELECT airline, airplane, COUNT(*) FROM flight GROUP BY airplane;
```

   (a) Report on how many airplane types there are.

   (b) Report on how many airline and airplane pairings there are.

   (c) Report on how many flights on each airline use each type of airplane each day.

   (d) None of the above, query is invalid.

9. Which SQL query would be used to answer the question, "When will Dijkstra land in Denver?"

   (a)
```
SELECT DISTINCT flight.arr_time
FROM flight, trip, trip_flight
WHERE trip.customer = 'Dijkstra, Edsger'
AND flight.arr_airport = 'DEN';
```

   (b)
```
SELECT flight.arr_time
FROM flight, trip, trip_flight AS tf
WHERE flight.flight_no = tf.flight_no
AND flight.airline = tf.airline
AND tf.trip_id = trip.trip_id
AND trip.customer = 'Dijkstra, Edsger'
AND flight.arr_airport = 'DEN';
```

   (c)
```
SELECT flight.arr_time
FROM flight, trip, trip_flight AS tf
WHERE flight.flight_no = tf.flight_no
AND flight.airline = tf.airline
AND tf.trip_id = trip.trip_id
AND trip.customer = 'Dijkstra, Edsger';
```

   (d) Any of the above.

10. Which of the following SQL queries is equivalent to the query below?
`SELECT website FROM airline WHERE name IN (SELECT airline FROM flight WHERE fare < 300);`

    (a) `SELECT website FROM airline WHERE name NOT IN (SELECT airline FROM flight WHERE fare >= 300);`

    (b) `SELECT website FROM airline, flight WHERE name = airline AND fare < 300;`

    (c) `SELECT website FROM airline WHERE name = (SELECT airline FROM flight WHERE fare < 300);`

    (d) None of the above.

11. It turns out that the passport information for Alan Turing is incorrect, and must be corrected. Why would it be a poor solution to delete Turing's record from the `customer` table and then insert a corrected record?

    (a) The operations are in the incorrect order; the insertion should come before the deletion.

    (b) The deletion would either cause a key constraint violation, or worse (if the key was set up this way), would silently delete Turing's frequent flier information from `airline_customer`.

    (c) Both (a) and (b).

    (d) None of the above, it is a brilliant solution.

These questions concern the WidgetCo entity-relationship diagram in figure 2.

12. Which of the following statements about WidgetCo's supply chain is most likely true?

    (a) Each supplier contributes a single widget to each of WidgetCo's products.

    (b) Assemblies may be made of multiple widgets; some widgets are used in more than one assembly.

    (c) Each widget is used in no more than a single WidgetCo product.

    (d) WidgetCo markets assemblies as different products in different markets.

13. Considering the relationship `sells`, what would be the best choice to map the relationship into a relational schema?

    (a) Make one relation combining attributes from `supplier` and `widget`.

    (b) Add a column `widget_id` into the `supplier` relation and make it a foreign key back to the `id` attribute of `widget`.

    (c) Add a column `supplier_id` into the `widget` relation and make it a foreign key back to the `id` attribute of `supplier`.

    (d) Nothing needs to be done to capture the relationship in the schema.

14. Considering the relationship `is part of`, what would be the best choice to map the relationship into a relational schema?

    (a) Make one relation combining attributes from `assembly` and `widget`.

    (b) Add a column `widget_id` into the `assembly` relation and make it a foreign key back to the `id` attribute of `widget`.

    (c) Add a column `assembly_id` into the `widget` relation and make it a foreign key back to the `id` attribute of `assembly`.

    (d) Make a cross-reference relation containing columns `widget_id` and `assembly_id` as foreign keys back to the `widget` and `assembly` relations, and use both columns as the primary key for the new relation.

15. Suppose WidgetCo decides they can improve their bottom line by taking competitive bids from suppliers for each type of widget. In what way should the ER diagram be modified?

    (a) The `sells` relationship will become N:M, and the widget cost will become an attribute of the `sells` relationship.

    (b) The `sells` relationship will become N:M, and the widget cost will become an attribute of the `supplier` entity.

    (c) The `supplier` entity should be made into a weak entity identified by the `sells` relationship.

    (d) No changes are necessary, the ER diagram is fine as is.

16. Why might the designer of the data model have decided to make `product` and `assembly` be separate entities, when there is a 1:1 relationship between them and they could be put into one relation?

    (a) The two entities model different concepts; `assembly` models an item that can be manufactured, together with details about its manufacture, while `product` models the customer-facing product catalog.

    (b) Not all of the possible assemblies will be part of the product catalog at all times.

    (c) The product catalog will be updated often with changing prices and stock quantities, while the facts about a particular assembly are relatively static.

    (d) All of the above.

These questions concern the relation and dependencies described below.

Relation `fruit`:
Attributes: {apple, banana, cherry, date, elderberry, fig}.
Key: {apple, banana}.
Dependencies:
{apple, banana} → {cherry, date, elderberry, fig}
apple → cherry
apple → date
date → elderberry
fig → date

17. This relation is:

    (a) In Boyce-Codd Normal Form (BCNF).

    (b) Is not in BCNF because it has a composite key.

    (c) Is not in BCNF because it has a functional dependency "apple → cherry", and apple is not a superkey.

    (d) Is not in BCNF because it has a functional dependency "apple → cherry", and cherry is not a superkey.

18. What is the closure of apple (apple$^+$)?

    (a) {apple, cherry, date}

    (b) {apple, cherry, date, elderberry}

    (c) {apple, banana, cherry, date, elderberry}

    (d) {apple, banana, cherry, date, elderberry, fig}

19. Which of the following would be a "good" decomposition of `fruit`?

    (a) R1 = {apple, cherry, date, fig}, R2 = {apple, banana, date, fig}

    (b) R1 = {apple, banana}, R2 = {cherry, date, elderberry, fig}

    (c) R1 = {date, fig}, R2 = {apple, banana, cherry, elderberry, fig}

    (d) R1 = {apple, banana, cherry, date}, R2 = {apple, banana, elderberry, fig}

20. Suppose we are given data for the `fruit` relation, but we suspect it doesn't conform to the constraints we were given. How might we verify whether or not {apple, banana} has duplicate values?

    (a) Try to create a primary key constraint on (apple, banana); if there are duplicate values, the key creation will fail.

    (b) Run the query `SELECT DISTINCT apple, banana FROM fruit;`. If the query returns fewer rows than in the data file given (or than a `SELECT COUNT(*) FROM fruit;` query), there are duplicate values.

    (c) Run the query
    `SELECT apple, banana FROM fruit GROUP BY apple, banana HAVING count(*) > 1;` and see if any rows are returned.

    (d) Any of the above.

flight: Primary Key (airline, flight_no), Foreign Key (airline) on airline(name)

airline	flight_no	dep_airport	arr_airport	dep_time	arr_time	fare	airplane
Southwest	473	DEN	RDU	10:10	14:35	270	B737
Southwest	474	RDU	DEN	15:45	17:15	295	B737
Delta	1010	LAX	CHI	6:45	13:05	310	A320
Delta	3333	CHI	LAX	12:50	16:15	355	B777
Delta	702	CHI	JFK	16:00	20:20	260	RJ145
Delta	910	JFK	CHI	8:35	11:20	260	RJ145

airline: Primary Key (name)

name	website
Southwest	southwest.com
Delta	delta.com
American	aa.com

customer: Primary Key (name)

name	passport_no
Turing, Alan	273001431
Hopper, Grace	300420023
Dijkstra, Edsger	918340799

trip: Primary Key (trip_id), Foreign Key (customer) on customer(name)

trip_id	customer	from_city	to_city	departure_date	return_date
1337	Hopper, Grace	New York	Los Angeles	2015-10-26	2015-11-4
1338	Dijkstra, Edsger	Raleigh/Durham	Denver	2015-10-26	2015-11-2

airline_customer:
Primary Key (airline, customer),
Foreign Key (airline) on airline(name),
Foreign Key (customer) on customer(name)

airline	customer	freq_flier_id
Southwest	Hopper, Grace	10001
Southwest	Dijkstra, Edsger	71042
American	Turing, Alan	10393992
Delta	Hopper, Grace	272100-442

trip_flight:
Primary Key (trip_id, airline, flight_no),
Foreign Key (trip_id) on trip(trip_id),
Foreign Key (airline, flight_no) on flight(airline, flight_no)

trip_id	airline	flight_no
1337	Delta	910
1337	Delta	3333
1337	Delta	1010
1337	Delta	702
1338	Southwest	474
1338	Southwest	473

Figure 1: Relational schema and sample tuples for a (vastly simplified) air travel database

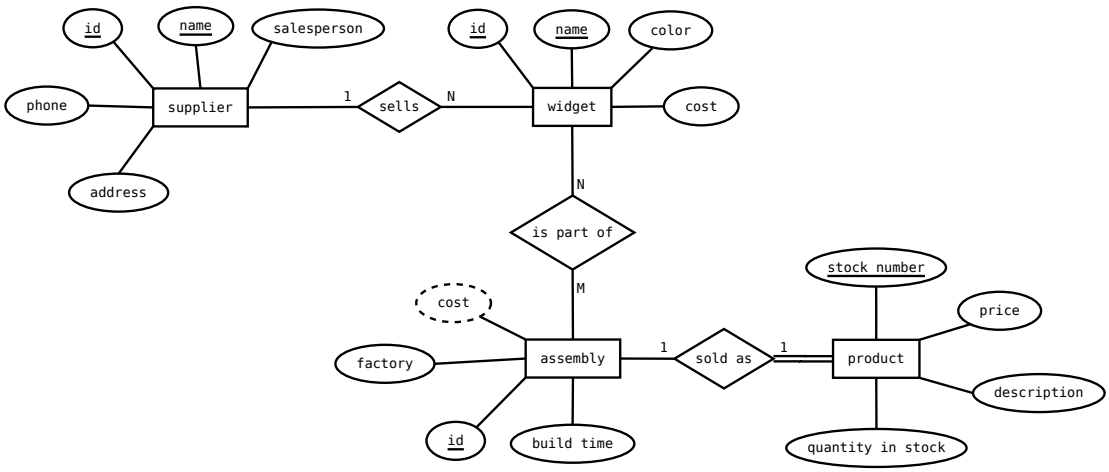

Figure 2: ERD for WidgetCo supply chain