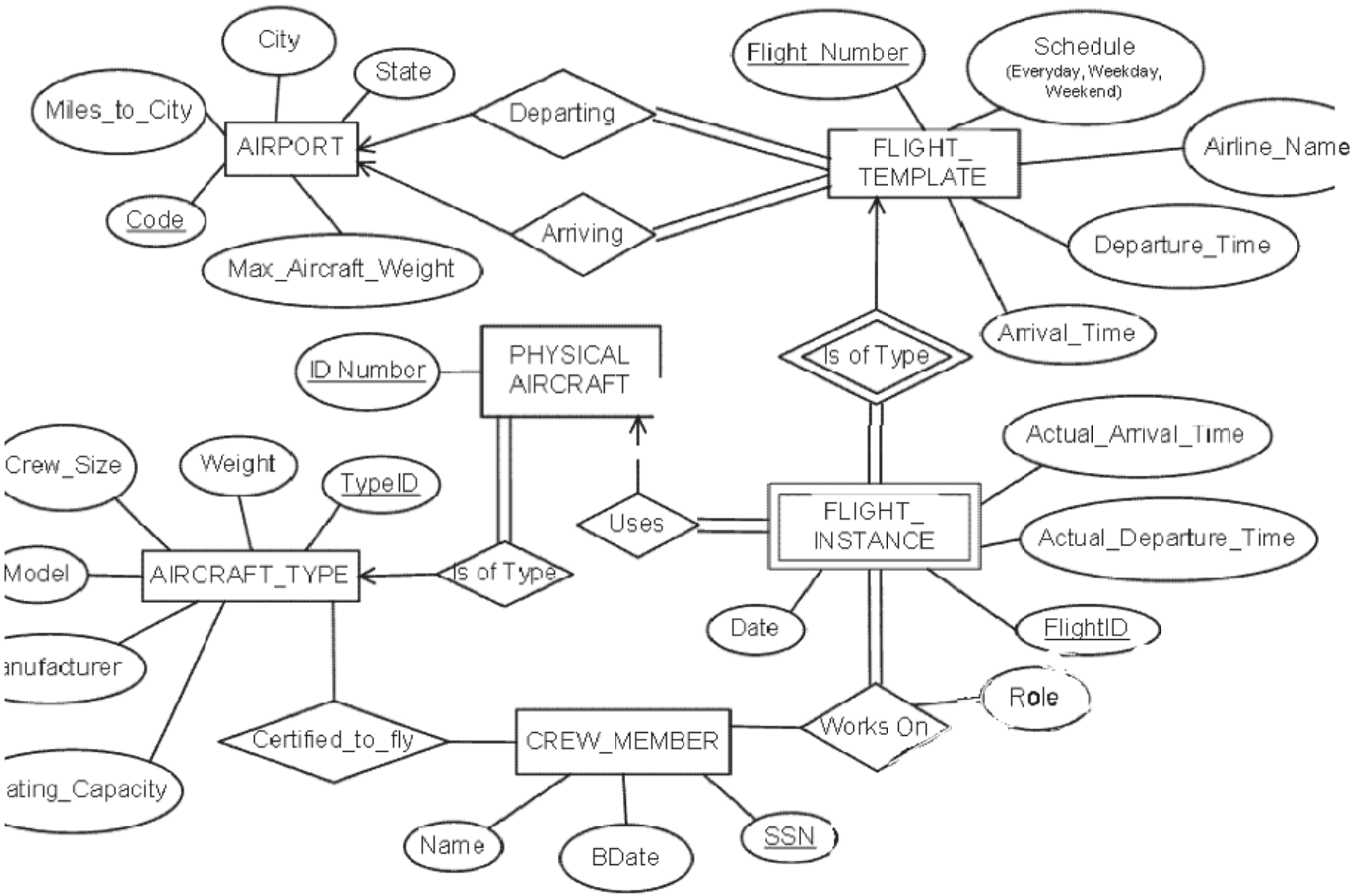
City
State
Miles_to_City
AIRPORT
Code
Max_Aircraft_Weight
Departing
Arriving
Flight_Number
Schedule
(Everyday, Weekday, Weekend)
FLIGHT_ TEMPLATE
Airline_Name
Departure_Time
Arrival_Time
Is of Type
ID Number
PHYSICAL AIRCRAFT
Actual_Arrival_Time
Uses
FLIGHT_ INSTANCE
Actual_Departure_Time
Date
FlightID
Crew_Size
Weight
TypeID
Model
AIRCRAFT_TYPE
Is of Type
anufacturer
ating_Capacity
Certified_to_fly
CREW_MEMBER
Works On
Role
Name
BDate
SSN

CREW_MEMBER	SSN	Name	Bdate
	123-45-678	John Doe	5-Jul-75
	997-65-432	Jane Smith	1-Mar-45

FLIGHT_INSTANCE	FlightID	FlightNum	Date	Plane_ID	Actual_Dep_Time	Actual_Arr_Time
	AA11091006	AA11	9-Jul-06	55555	0930	1300
	JB234090806	JB234	8-Sep-06	55558	1600	1730

FLIGHT_TEMPLATE	FlightNum	Schedule	Departure_Time	Arrival_Time	Arrival_Code	Departure_Code	Airline_Name
	AA11	Weekly	0930	1300	JFK	LAX	American
	JB234	Weekend	1700	1830	BWI	JFK	JetBlue

AIRPORT	Code	City	State	Miles_to_City	Airplane_Weight_Limit
	BWI	Baltimore	MD	20	100
	JFK	New York	NY	15	200

Certified_to_Fly	Crew_SSN	Aircraft_Type
	997-65-432	B747
	927-35-432	A67

AIRCRAFT_TYPE	TypeID	Model	Manufacturer	Seating Capacity	Weight	Crew
	B747	747	Boeing	45	30	5
	A67	67	Airbus	200	100	10

PHYSICAL_AIRCRAFT	ID Number	Aircraft_Type
	55555	A67
	55558	B23

Works_on_Flight	Crew_SSN	FlightID	Role
	997-65-432	AA11091006	Pilot
	997-65-432	JB234090806	CoPilot

PHYSICAL_AIRCRAFT	ID Number	Aircraft_Type
	55555	A67
	55558	B23

FLIGHT_INSTANCE	FlightID	FlightNum	Date	Plane_ID	Actual_Dep_Time	Actual_Arr_Time
	AA110910061	AA11	9-Jul-06	55555	930	1300
	JB234090806	JB234	8-Sep-06	55558	1600	1730

AIRPORT	Code	City	State	Miles_to_City	Max_Aircraft_Weight
	BWI	Baltimore	MD	20	100
	JFK	New York	NY	15	200

CREW_MEMBER	SSN	Name	Bdate
	123-45-678	John Doe	7/5/1975
	997-65-432	Jane Smith	3/1/1945

Works_on_Flight	Crew_SSN	FlightID	Role
	997-65-432	AA110910061	Pilot
	997-65-432	JB234090806	CoPilot

AIRCRAFT_TYPE	TypeID	Model	Manufacturer	Seating Capacity	Weight	Crew
	B747	747	Boeing	45	30	5
	A67	67	Airbus	200	100	10

Certified_to_Fly	Crew_SSN	Aircraft_Type
	997-65-432	B747
	927-35-432	A67

FLIGHT_TEMPLATE	FlightNum	Schedule	Departure_Time	Arrival_Time	Arrival_Code	Departure_Code	Airline_Name
	AA11	Weekly	930	1300	JFK	LAX	American
	JB234	Weekend	1700	1830	BWI	JFK	JetBlue

1.3

A) List the city, airport-code and miles from the city of all airports in Texas:

Π City,Code,Miles_to_city (σ State="TX"(AIRPORT))

B) For each Delta airline flight that is scheduled to depart BWI weekdays before 0900 hours, list the scheduled arrival time and arrival city code.

Π Arrival_Time,Destination_Code (σ Airline_Name="Delta" ^ Departure_Code="BWI" ^ Schedule="Weekdays" ^ Departure_Time < 0900 (FLIGHT_TEMPLATE))

C) List the actual arrival time, arrival city code, and airplane ID number for all flights on 29-SEP-12.

Π Actual_Arr_Time,Arrival_Code,Plane_ID ((σ Date="29-Sep-15" (FLIGHT_INSTANCE)) $\bowtie$ FLIGHT_TEMPLATE)

Note: implicit join criteria: only FlightNum in common (will follow this convention).

D) List airport code, city and state of the destination of all flights that are scheduled to depart BWI on weekends.

FLTBWIWKND $\leftarrow$ σ Departure_Code="BWI" ^(Schedule="Weekend" v Schedule="Daily") (FLIGHT_TEMPLATE)

Π Code, City, State (FLTBWIWKND $\bowtie$ Arrival_Code=Code AIRPORT)

E) List name, SSN, birth date and position working of all flights on 30-SEP-15 that actually arrived in BWI before 2200 hours.

FLT30SEP15$\leftarrow$ Π FlightID,FlightNum (σActual_Arr_Time < 2200 ^ Date="30-SEP-15" (FLIGHT_INSTANCE))

Make sure they are from BWI (FlightNum in common.)

FLT30SEP15BWI $\leftarrow$ Π FlightID (σ Arrival_Code= "BWI"

(FLT30SEP15 $\bowtie$ FLIGHT_TEMPLATE))

Π Name, SSN, BDate, Role (FLT30SEP15BWI $\bowtie$ Works_On_Flight $\bowtie$ CrewSSN=SSN CREW_MEMBER)

F) List all flight crew members that are certified to fly Boeing 737's that actually flew Boeing 737 on 29-SEP-15.

B787 $\leftarrow$ Π typeID (σ Model=787 ^ Manufacturer="Boeing" (AIRCRAFT _TYPE))

FLTS03OCT15$\leftarrow$ Π FlightID , Plane_ID (σ Date="03-OCT-15" (FLIGHT_INSTANCE))

This finds all the flights that used 787 yesterday:

B78703OCT15 $\leftarrow$ Π FlightID , typeID (FLTS03OCT15 $\bowtie$ Plane_ID=ID_Number

PHYSICAL_AIRCRAFT $\bowtie$ B787)

This finds all the crew on those flights that are certified to fly:

Π Name ((FLTSO3OCT15 $\bowtie$ Works_On_Flight $\bowtie$ Certified_To_Fly) $\bowtie$ CrewSSN=SSN CREW_MEMBER)

G) List the types of aircraft (manufacturer, model, weight, seats) that are small enough to land in one of the airports in West Virginia.
Find all the airplane types that can land on an airport, for every airport in West Virginia.

Π Manufacturer, Model, Weight, Seating_Capacity (AIRCRAFT_TYPE $\bowtie$ Weight=Max_Aircraft_Weight (σ State="WV" AIRPORT))

H) List the airlines that have flights from some city in Maryland to some city in California.
MDCODES= Π Code (σ state="MD" AIRPORT)
CALCODES = Π Code (σ state="CA" AIRPORT)

Π Airiline (MDCODES $\bowtie$ MDCODES.Code=Departure_Code FLIGHT_TEMPLATE $\bowtie$ Arrival_Code=CALCODES.Code CALCODES)

PART 2.

1. List the name of every bar that Donald Trump has visited more than once.

VISITEDBARS_ Π BNO (σ DName="Donald Trump" ^ NumberOfTimes>1(DRINKER $\bowtie$ VISIT))
BNO in common:

Π BarName (VISITEDBARS $\bowtie$ BARS)

Tuple Relational Calculus:

{ t | $\exists$ b $\in$ BAR (t [BarName] = b [BarName]

^ $\exists$ u $\in$ VISIT (u[BNO] =b [BNO]

^ $\exists$ d $\in$ DRINKER (d[DLicNo] =u[DLicNo]'
^ d[DName]="Donald Trump"
^ u[NumberOfTimes]>1)))}

2. List the names of bars in Maryland that are not in the Baltimore and do not serve Coors Lite.
MDBARS _ Π BNO (σ BState="MD^ BCity _ Baltimore(BAR))
MDBARSNOCOORS_ (MDBARS) - Π BNO (σ BeerName="Coors Lite" (MDBARS $\leftrightarrow$ SERVES))
BNO in common:

Π BarName (MDBARSNOCOORS $\bowtie$ BAR)

Tuple Relational Calculus:

{ t | $\exists$ b $\in$ BAR (t [BarName] = b [BarName]
^ b[BState]="MD"
^ b[BCity] _ "Baltimore"

^ $\neg$ $\exists$ s $\in$ SERVES (b [BNO] = s [BNO] ^ s[BeerName] = "Coors Lite"))}

3. List the names of all people under 30 who have visited at least one bar in Georgetown and like Coors Lite and do not like Bud Lite.

PEOPLEU30 ← Π DLicNo, DName (σ Age<30(DRINKER))

VISITEDGBAR_ Π DLicNo, DName ((PEOPLEU30 $\bowtie$ VISIT) $\bowtie$ (σ BCity = "Georgetown" (BAR)))

Π Name (σ BeerName="Coors Lite" (VISITEDGBAR $\bowtie$ LIKES) -

Π Name (σ BeerName="Bud Lite" (VISITEDGBAR $\bowtie$ LIKES)

Tuple Relational Calculus:

{ t | $\exists$ d $\in$ DRINKER (t [DName] = d [DName]
^ d[Age]<30

^ $\exists$ u $\in$ VISIT (u[DLicNo] =d [DLicNo]

^ $\exists$ b $\in$ BAR (b [BNO] = u [BNO]
^ b[BCity]="Georgetown"

^ $\exists$ k1 $\in$ LIKES (k1 [LIKES]= d [DLicNo]
^ k1[BeerName]= "Coors Lite")

^ $\neg$ $\exists$ k2 $\in$ LIKES (k2 [LIKES]= d [DLicNo]
^ k2[BeerName]= "Bud Lite")))}

4. List the name and age of everyone who has visited at least one bar that Donald Trump has visited.

BARSDTVISITED ← Π BNO (σ DName="Donald Trump" (DRINKER $\bowtie$ VISITED))
People that have visited the same bar.

RESULT← Π DLicNo (VISIT $\bowtie$ BARSDTVISITED)

Π DName,Age (RESULT $\bowtie$ DRINKER) - Π DName,Age (σ DName="Donald Trump" (DRINKER))

5. List the names and ages of all people who have visited every bar in Towson.

BARSIN_T Π BNO ← (σBCity = Towson(BAR))

Π DName, Age ((VISIT ÷ BARSIN_T) $\bowtie$ DRINKER)

6. List the names and ages of people who have visited at least every bar that Barak Obama has visited, and has visited all of these bars the identical number of times that Barak Obama has visited.

BARSBOVISITED ← Π BNO, NumberOfTimes ((σDName="Barak Obama" (DRINKER)) $\bowtie$ VISIT)

RESULT ← Π DLicNo(VISIT ÷ BARSBOVISITED) -Π DLicNo (σDName="Barak Obama" (DRINKER))

Π DName, Age (RESULT $\bowtie$ DRINKER)
Note: The result removes Barak Obama.

7. List the names and ages of people who have visited every bar that Donald Trump has visited and have never visited a bar that Carly Fiorina has visited.

DTVISIT ← Π BNO ((σDName="Donald Trump" (DRINKER)) ⋈ VISIT)

CFVISIT← Π BNO ((σDName="Carly Fiorina" (DRINKER)) ⋈ VISIT)

RESULT← Π DLicNo(DTVISIT ÷ VISIT) - Π DLicNo(CFVISIT ⋈ VISIT)

Π DName, Age (RESULT ⋈ DRINKER)

8. List the names of people who don't like the beer named for them (e.g. "Sam Adams" drinking a beer called "Sam Adams"), but have visited at least 1 bar named for them.

BARNAMED ←Π DLicNo, BNO (DRINKER ⋈ DName=BarName BAR)

Find all the tuples that have DLicNo and BNO in common in BARNAMED ⋈ VISITED which yields people who have visited the bar that is named after them.

VISITEDBARNAMED ← Π DLicNo, DName BARNAMED ⋈ VISITED)
Find the people that like the beer named after them and remove them from the list:
Π DName (VISITEDBARNAMED) –

Π DName (σDName=BeerName (VISITEDBARNAMED ⋈ LIKES))
Assumes that if the beer is not associated with the user in LIKES relation then it is not liked.

9. List the name of every bar that serves a beer that Donald Trump doesn't like.
First find all the beers served that are not what Jenna likes.
DTDISLIKES ← Π BeerName (SERVES) - Π BeerName ((σDName="Donald Trump" (DRINKER))

⋈ LIKES)
Now find all the bars that serve any of those beers.

Π BarName (MRDISLIKES ⋈ SERVES ⋈ BAR)

10. List the name of every bar in Towson that serves no beer that is served in a Bar in Timonium.

BEERINTIM ← Π BeerName ((σBCity="Timonium" (BAR)) ⋈ SERVES)

BARINTOW_BEER ← Π BarName, BeerName ((σBCity="Towson" (BAR)) ⋈ SERVES)
Now find all the beer that is only served in Towson.
BEERONLYINTOW← (Π BeerName BARINTOW_BEER) - BEERINTIM
Now find the bars in towson that serve that beer. (BeerName is the equality)

Π BarName (BEERONLYINTOW ⋈ BARINTOW_BEER)

11. List the name of all beers that both Donald Trump and Carly Fiorina like and are served at the same bar in the database (i.e. a bar where both people could order a beer that they like).

BARSDTLIKES ← Π BarName ((Π BeerName (σDName="Donald Trump" (LIKES ⋈ DRINKER)))

⋈ SERVES)

BARSCFLIKES ← Π BarName ((Π BeerName (σDName="Carly Fiorina" (LIKES ⋈

DRINKER))) ⋈ SERVES)

Π BarName(BARSDTLIKES ⋈ BARSCFLIKES)

12. List all the beers served in Donald Trump's home city in a bar that Barak Obama has visited that are not served in Joe Biden's home city and that Michelle Obama doesn't like.

BARSDT← Π BNO(σDName="Donald Trump" (DRINKER ⋈DCity=BCity BAR))

BARAKBARS← Π BNO(σDName="Barak Obama" (DRINKER ⋈ VISIT))

BEERSDONALDBARAK← Π Π BeerName((BARSDT⋈ BARAKBARS) ⋈
SERVES)

BEERSBIDEN ←Π BeerName (Π BNO(σDName="Joe Biden" (DRINKER ⋈DCity=BCity BAR))) ⋈
SERVES
BEERSNOTBIDEN ←Π BeerName(SERVES - BEERSBIDEN)

BEERSMICHLIKES ←Π BeerName (σDName="Michelle Obama" (LIKES ⋈ DRINKER))
BEERSNOTMICH←Π BeerName(SERVES - BEERSMICHLIKES)

Π BeerName(BEERSDONALDBARAK ⋈ BEERSNOTBIDEN ⋈ BEERSNOTMICH)