Name: *SAMPLE SOLUTION*

Section (315/415/615):

MIDTERM EXAM - 601.315/415/615 - Databases

Date: Thursday, November 1, 2018, 3-4:15 PM

The total number of points in this exam is 75 for both 601.315 and 601.415/615 students (although the questions are mostly different). If you work at approximately 1 minute per point, you should finish on time.

Question 1 - Relational Algebra (5 points)

Express the following query in the Relational Algebra. The tables that are used in this (and following) questions are found on your supplementary handout.

- (5 points) List the GameID, date and opponent of all games won by the BasketCases in 2018.

$$BCGame \leftarrow \sigma_{Season="2018" \wedge WinningTeam="BasketCases"}(Game)$$
$$OA \leftarrow \Pi_{GameID,AwayTeam,Date}(\sigma_{HomeTeam="BasketCases"}(BCGame))$$
$$OH \leftarrow \Pi_{GameIdD,HomeTeam,Date}(\sigma_{AwayTeam="BasketCases"}(BCGame))$$
$$Result \leftarrow OA \bigcup OH$$

Question 2 - Relational Algebra (5 points)

Express the following query in the relational algebra:

(a) (5 points) **601.315 only:** List the name and host city of all teams who won every game they played in 2018.

(b) (5 points) **601.415/615 only:** List the name and host city of all teams who won every game they played in 2018, but did not win any game in 2017.

601.315:

$$lostin2018Away \leftarrow \Pi_{Team.TName,Team.HostCity}$$
$$(\sigma_{Game.AwayTeam=Team.TName \wedge Game.Season=2018 \wedge Game.winningTeam \neq Team.TName}(TEAM \times GAME))$$
$$LostIn2018Home \leftarrow \Pi_{Team.TName,Team.HostCity}$$
$$(\sigma_{Game.HomeTeam=Team.TName \wedge Game.Season=2018 \wedge Game.winningTeam \neq Team.TName}(TEAM \times GAME))$$
$$Result \leftarrow \Pi_{TName,HostCity}(Team) - LostIn2018Away - LostIn2018Home$$

601.415/615:

$$lostin2018Away \leftarrow \Pi_{Team.TName,Team.HostCity}$$
$$(\sigma_{Game.AwayTeam=Team.TName \wedge Game.Season=2018 \wedge Game.winningTeam \neq Team.TName}(TEAM \times GAME))$$
$$LostIn2018Home \leftarrow \Pi_{Team.TName,Team.HostCity}$$
$$(\sigma_{Game.HomeTeam=Team.TName \wedge Game.Season=2018 \wedge Game.winningTeam \neq Team.TName}(TEAM \times GAME))$$
$$WinIn2017 \leftarrow \Pi_{Team.TName,Team.HostCity}$$
$$(\sigma_{Game.HomeTeam=Team.TName \wedge Game.Season=2017 \wedge Game.winningTeam=Team.TName}(TEAM \times GAME))$$
$$Result \leftarrow \Pi_{TName,HostCity}(Team) - LostIn2018Away - LostIn2018Home - WinIn2017$$

Question 3 - Relational Algebra (5 points)

(a) (5 points) **601.315 only:** List the names all players who have scored more points than Wally Whinger in the same game (e.g. if Colin Creep scores 106 points in the same game that Wally scores 103 points then he qualifies).

(b) (5 points) **601.415/615 only:** List the names all players who have scored more points than Wally Whinger in the same game but has never scored more points than Steven Simpleton in the same game (e.g. if Colin Creep scores 106 points in the same game that Wally scores 103 points then he satisfies the the first clause).

601.315:

$$WGames \leftarrow PG1 \leftarrow PLAYED\_IN\_GAME$$
$$\Pi_{GameID,PointsScored}(\sigma_{PName=wallywhigner(PG1)})$$
$$OtherGames \leftarrow \sigma_{PName \neq WallyWhigner(PG1)}$$
$$WGames' \leftarrow \rho_{wallypts/pointscored}(WGames)$$
$$OtherGame' \leftarrow \rho_{otherpts/pointsscored}(Othergames)$$
$$MoreThanWally \leftarrow \Pi_{PName}(\sigma_{Others>wallypts(WGames' \bowtie OtherGames')})$$

601.415/615:

$$PG1 \leftarrow PLAYED\_IN\_GAME$$
$$PG2 \leftarrow PLAYED\_IN\_GAME$$
$$PG3 \leftarrow PLAYED\_IN\_GAME$$
$$Result \leftarrow \Pi_{PG1.PName}(\sigma_{PG1.GameID=PG2.GameID \wedge PG2.PName=\text{"}WallyWhinger\text{"}}$$
$$\wedge PG1.PointsScored > PG2.PointsScored$$
$$\wedge PG1.GameID=PG3.GameID \sigma PG3.PName=\text{"}StevenSimpleton\text{"}$$
$$\wedge PG1.PointsScored < PG3.PointsScored(PG1 \times PG2 \times PG3))$$

Question 4 - Relational Algebra (5 points)

Express the following query in the relational algebra.

(a) (5 points) **601.315 only:** List the names, birth city and birth country of all players who have never played a game in the city of their birth (you can assume a game is always played in the host city of the home team).

(b) (5 points) **601.415/615 only:** List the names, birth city and birth country of all players who have never played a game in the city of their birth and have never played against a team whos host city is the city of their birth. (you can assume a game is always played in the host city of the home team).

601.315:

$$T \leftarrow PlayedInGame \bowtie Game$$
$$T_2 \leftarrow T \bowtie_{HomeTeam=TName} Team$$
$$T_3 \leftarrow T_2 \bowtie_{HostCity=CityofBirth, PName=PName} Player$$
$$PlayedInHomeCity \leftarrow \Pi_{PName}(T3)$$
$$Others \leftarrow \Pi_{PName}(Player) - PlayedInHomeCity$$
$$Result \leftarrow \Pi_{PName, CityofBirth, Country}(Others \bowtie Player)$$

601.415/615:

$$Host \leftarrow (\sigma_{cityofbirth \neq HostCity})(PLAYER \bowtie PLAYS\_FOR \bowtie TEAM \bowtie_{HomeTeam=TName} GAME)$$
$$T \leftarrow TEAM$$
$$Against \leftarrow (\sigma_{cityofBirth \neq T.HostCity}(PLAYER \bowtie PLYS\_FOR \bowtie_{AwayTeam=TName} GAME \bowtie_{HomeTeam=T.TName} T$$
$$Result \leftarrow \Pi_{PName, CityofBrith, CountryofBirth}(Host \bigcap Against)$$

Question 5 - Tuple Relational Calculus (6 points)

Express the following query in Tuple Relational Calculus:

(a) (6 points) **601.315 only:** List the name, birthdate, sex and birthcountry of all players who were born in the same country as Wally Winger *and* were born on the same exact date as Wally Whinger *and* have the same sex as Wally Whinger *and* has played for a team that Wally Whinger has played for in some year, but were not born in the same city as Wally Whinger.

$\{ t \mid \exists p \in PLAYER(t[name] = p[name] \wedge p[Bdate] = t[Bdate] \wedge t[sex] = p[sex] \wedge t[CountryofBirth] = p[CountryofBirth]$
$\wedge \exists s \in Player(s[PName] = "WallyWinger" \wedge s[CountryofBirth] = p[CountryofBirth] \wedge$
$s[Bdate] = p[Bdate] \wedge s[sex] = p[sex]$
$\wedge \exists pf \in Plays\_for(pf[Pname] = "WallyWinger"$
$\wedge \exists pf2 \in Plays\_for(pf2[Pname] = p[name] \wedge pf2[Tname] = pf[Tname] \wedge \neg(p[CityofBirth] = s[CityofBirth]))))\}$

(a) (6 points) **601.415/615 only:** List the name, birthdate, sex and birthcountry of all players who were born in the same country as Wally Winger *and* were born on the same exact date as Wally Whinger *and* have the same sex as Wally Whinger *and* has played for a team that Wally Whinger has played for in some year, but have *never* played in the same game as Wally Whinger (on the same or opposing team).

$\{ t \mid \exists p \in PLAYER(t[name] = p[name] \wedge p[Bdate] = t[Bdate] \wedge t[sex] = p[sex] \wedge t[CountryofBirth] = p[CountryofBirth]$
$\wedge \exists s \in Player(s[PName] = "WallyWinger" \wedge s[CountryofBirth] = p[CountryofBirth] \wedge$
$s[Bdate] = p[Bdate] \wedge s[sex] = p[sex]$
$\wedge \exists pf \in Plays\_for(pf[Pname] = "WallyWinger"$
$\wedge \exists pf2 \in Plays\_for(pf2[Pname] = p[name] \wedge pf2[Tname] = pf[Tname]$
$\wedge \neg(\exists g \in Played\_in\_game(t[PName] = g[PName]$
$\wedge \exists g1 \in Played\_in\_game(g1[PName] = "WallyWinger" \wedge g1[GameID] = g[GameID])))))))\}$

Question 6 - SQL (25 points)

Express the following queries in SQL:

(a) **601.315 only:** List the names and birth country of players who were played for a US team in 2018 but were born in a different country.

```
SELECT p.PName, p.CountryofBirth
FROM PLAYER p, TEAM t, PLAYS_FOR f
WHERE p.PName=f.PName AND f.season = 2018 AND f.TName=t.TName
        AND t.HostCountry!=p.CountryofBirth  AND p.CountryofBirth!=''USA''
```

(aa) **601.415/615 only:** List the names and birth country of players who have never played for a team whose host country is the country where they were born.

```
SELECT p.PName, p.CountryofBirth
FROM PLAYER p, TEAM t, PLAYS_FOR pf
WHERE p.PName=pf.PName AND pf.TName=t.TName AND t.HostCountry!=p.CountryofBirth;
```

(b) **601.315 only:** List the names and birthdate of all players born after 1/1/84 who have played for more than two teams.

```
SELECT Player.PName, Player.Bdate
FROM
  (SELECT PName, COUNT(DISTINCT TName) as numTeams
  FROM PLAYS_FOR
  GROUP BY PName) as C
JOIN
  PLAYER ON C.PName = Player.PName
WHERE
  C.numTeams > 2 AND Player.BDate > 1/1/84
```

(bb) **601.415/615 only:** List the names and birthdate of all players born after 1/1/84 who have played for more than two teams, and also include the total number of teams that the player has ever played for.

```
SELECT Player.PName, Player.Bdate, C.numTeams
FROM
  (SELECT PName, COUNT(DISTINCT TName) as numTeams
  FROM PLAYS_FOR
  GROUP BY PName) as C
JOIN
  PLAYER ON C.PName = Player.PName
WHERE
  C.numTeams > 2 AND Player.BDate > 1/1/84
```

(c) (**315 and 415/615:** For each team in the league, list the total number of points scored by Colette Cretin when playing against that team.

```
SELECT T.team, SUM(T.PS)
FROM
 (
  (SELECT G.HomeTeam as team, SUM(PIG.PointsScored) as PS
  FROM Played_In_Game as PIG
  JOIN Game as G ON PIG.GameID = G.GameID
  JOIN Plays_For CPF ON PIG.PName = CPF.PName
  GROUP BY G.HomeTeam
  WHERE PIG.PName = 'Colette Cretin'
  AND G.HomeTeam <> CPF.TName)

  UNION

  (SELECT G.AwayTeam as team, SUM(PIG.PointsScored) as PS
  FROM Played_In_Game as PIG
  JOIN Game as G ON PIG.GameID = G.GameID
  JOIN Plays_For CPF ON PIG.PName = CPF.PName
  Group BY G.AwayTeam
  WHERE PIG.PName = 'Colette Cretin'
  AND G.AwayTeam <> CPF.TName)
 ) as T
GROUP BY T.team
```

(d) **601.315 only:** Name the female player with the highest total points scored in 2017, and include that total.

```
SELECT Points2017.PName
FROM
  (SELECT PIG.PName as PName, SUM(PIG.PointsScored) as PS
  FROM Played_In_Game PIG
  JOIN Player P ON PIG.PName = P.PName
  JOIN Game G ON PIG.GameID = G.GameID
  GROUP BY PIG.PName
  WHERE P.Sex = 'Female'
  AND G.Season = 2017) as Points2017
WHERE Points2017.PS =
  SELECT MAX(Points2017v2.PS)
  FROM
    (SELECT PIG.PName as PName, SUM(PIG.PointsScored) as PS
    FROM Played_In_Game PIG
    JOIN Player P ON PIG.PName = P.PName
    JOIN Game G ON PIG.GameID = G.GameID
    GROUP BY PIG.PName
    WHERE P.Sex = 'Female'
    AND G.Season = 2017) as Points2017v2
```

(dd) **601.415/615 only:** Name the female player who is most improved between 2017 and 2018 (the increase in her total points from 2017 to 2018 is greatest).

```
SELECT T.PName
FROM
  (SELECT Points2017.PName as PName, (Points2018.PS - Points2017.PS) as diff
  FROM
    (SELECT PIG.PName as PName, SUM(PIG.PointsScored) as PS
    FROM Played_In_Game PIG
    JOIN Player P ON PIG.PName = P.PName
    JOIN Game G ON PIG.GameID = G.GameID
    GROUP BY PIG.PName
    WHERE P.Sex = 'Female'
    AND G.Season = 2017) as Points2017
  JOIN
    (SELECT PIG.PName as PName, SUM(PIG.PointsScored) as PS
    FROM Played_In_Game PIG
    JOIN Player P ON PIG.PName = P.PName
    JOIN Game G ON PIG.GameID = G.GameID
    GROUP BY PIG.PName
    WHERE P.Sex = 'Female'
    AND G.Season = 2018) as Points2018
  ON Points2017.PName = Points2018.PName) as T
WHERE T.diff =
  (SELECT MAX(Points2018v2.PS - Points2017v2.PS) as diff
  FROM
    (SELECT PIG.PName as PName, SUM(PIG.PointsScored) as PS
    FROM Played_In_Game PIG
    JOIN Player P ON PIG.PName = P.PName
    JOIN Game G ON PIG.GameID = G.GameID
    GROUP BY PIG.PName
    WHERE P.Sex = 'Female'
    AND G.Season = 2017) as Points2017v2
  JOIN
    (SELECT PIG.PName as PName, SUM(PIG.PointsScored) as PS
    FROM Played_In_Game PIG
    JOIN Player P ON PIG.PName = P.PName
    JOIN Game G ON PIG.GameID = G.GameID
    GROUP BY PIG.PName
    WHERE P.Sex = 'Female'
    AND G.Season = 2018) as Points2018v2
  ON Points2017v2PName = Points2018v2.PName)
```

(e) **601.315 only:** List the names and birthdates of all players who have never played for more than one team.

```
SELECT P.PName, P.BDate
FROM Player P, (SELECT PName, Count(TName) NumTeam
                FROM Plays_for
                GROUP BY PName ) T1
WHERE P.Pname=T1.Pname AND T1.NumTeam=1
```

(ee) **601.415/615 only:** How many players in the database have played for more than two teams in the same host country in their entire careers.

```
SELECT  count(*)
FROM    SELECT T.PName
        FROM Team T,( SELECT DISTINCT PName, TName
                      FROM PLAYS_FOR) PF
        WHERE T.TName=PF.TName
        GROUP BY T.PName, T.HostCountry
        HAVING Count(T.TName)>2
```

Question 7 - QBE (15 points)

Express the following queries in QBE. To simplify your work, table shells have been provided. Just fill in the appropriate cells with variables/values.

(a) (5 points) List the name and birthdate of all players who have played in a game against someone who played in a game against Wally Whinger, but were not born in the same country as Wally Winger.

PLAYER	PName	BDate	Sex	CityOfBirth	CountryofBirth
	P._pn	**P.**			**_c**
	Wally Whinger				**¬ _c**

TEAM	HostCity	TName	HostCountry

PLAYS_FOR	PName	TName	Season
	_pn	**_t1**	
	_p2	**_t2**	
	Wally Whinger	**_t3**	

GAME	GameID	HomeTeam	AwayTeam	Date	Season	WinningTeam	HomeScore	AwayScore

PLAYED_IN_GAME	PName	GameID	Position	PointsScored
	_pn	**_g1**		
	_p2	**_g1**		
	_p2	**_g2**		
	Wally Whinger	**_g2**		

Conditions

(b) (5 points) List the name, birthdate, sex and birthcountry of all players who were not born in the same country as Wally Winger *and* were not born on the same exact date as Wally Whinger *and* do not have the same sex as Wally Whinger and have never played for a team that Wally Whinger has ever played for, *and* has never played in the same game as Wally Whinger (on the same or opposing team).

PLAYER	PName	BDate	Sex	CityOfBirth	CountryofBirth
	P._pn	**P._b**	**p._s**		**P._c**
	Wally Whinger	¬_b	¬_s		¬_c

TEAM	HostCity	TName	HostCountry

PLAYS_FOR	PName	TName	Season
	_pn	**_t**	
¬	**Wally Whinger**	**_t**	

GAME	GameID	HomeTeam	AwayTeam	Date	Season	WinningTeam	HomeScore	AwayScore

PLAYED_IN_GAME	PName	GameID	Position	PointsScored
	_pn	**_g**		
¬	**Wally Whinger**	**_g**		

Conditions

(c) List the name, birthdate and birth city of all players who have played for a team with a host city and country that is the same as the city/country where the player was born.

PLAYER	PName	BDate	Sex	CityOfBirth	CountryofBirth
	P._pn	**P._bd**		**P._citb**	**_coub**

TEAM	HostCity	TName	HostCountry
	_citb	**_tn**	**_coub**

PLAYS_FOR	PName	TName	Season
	_pn	**_tn**	

GAME	GameID	HomeTeam	AwayTeam	Date	Season	WinningTeam	HomeScore	AwayScore

PLAYED_IN_GAME	PName	GameID	Position	PointsScored

Conditions

Question 8 - Functional Dependencies (9 points)

Consider the instance of the relation **r**(A,B,C):

A	B	C
1	2	fever
2	6	cold
3	2	fever
6	4	healthy

State whether the following Functional Dependencies are satisfied by the relation above (circle yes or no).

FD	Satisfied?	
A $\rightarrow$ B	**Yes** / No	
B $\rightarrow$ A	Yes / **No**	
C $\rightarrow$ B	**Yes** / No	
C $\rightarrow$ A	Yes / **No**	
BC $\rightarrow$ A	Yes / **No**	
A $\rightarrow$ ABC	**Yes** / No	
B $\rightarrow$ ABC	Yes / **No**	

List a possible Candidate Key for **r**, given the values in the instance above: __**A**__

CERTIFICATION PAGE

By signing below, I promise that my answers on this exam are entirely my own work. I have not looked at the answers written by others and I have not allowed others to look at my answers. I also have not consulted any books or notes while taking this exam besides the 2 single sided pages allowed.

My Signature: