Concordia University
Department of Computer Science & Software Engineering
Midterm Exam
COMP 353 – Databases

Exam Date: July 25th, 2018 **Student Name:**

Duration: 120 minutes **Student ID:**

Instructions

1. Closed book exam.
2. Answer all questions in the space provided under each question. No mark will be given to answers appearing elsewhere. You may use the back of the page if needed.
3. Please be brief but precise in your justifications for all questions.
4. State all your assumptions clearly.

Marking

	Value	Grade
Question 1: Multiple Choice	20	15
Question 2: ER Modeling	40	33
Question 3: Functional Dependencies	40	28
Total	**100**	76

Question 1: Multiple Choice (20 Points)

There are 5 multiple-choice questions in this part. To choose an answer, simply put an arrow "->" to the left of the chosen answer(s) (if any!), there can be more than one correct answer for the same question. A correct choice will get 4 points. An incorrect answer will get –1. The minimum total mark for this question is 0.

a) The advantages of Database is that
- It enforces the redundancy of data
- -> It provides concurrent access to shared data
- -> It provides data abstraction and independence

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if i had to choose one

b) Which one is part of the DML
- -> Insert.
- Delete.
- Update.
- Create.

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DDL = definition
DML = manipulation

c) Which of the following statements is NOT correct?
- Data Independence is the ability to modify definition of schema at one level without affecting the schema definition(s) at a higher level
- -> Logical Data Independence is the ability to modify physical schema without causing the conceptual schema to be modified
- -> Physical Data Independence is the ability to modify logical schema without causing application programs to be rewritten

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d) Every candidate key is also a
- -> Superkey (minimal)
- Primary key

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e) Which of the following is a theoretical query language
- SQL
- -> Relational Algebra
- -> Relational Calculus
- Datalog

-1

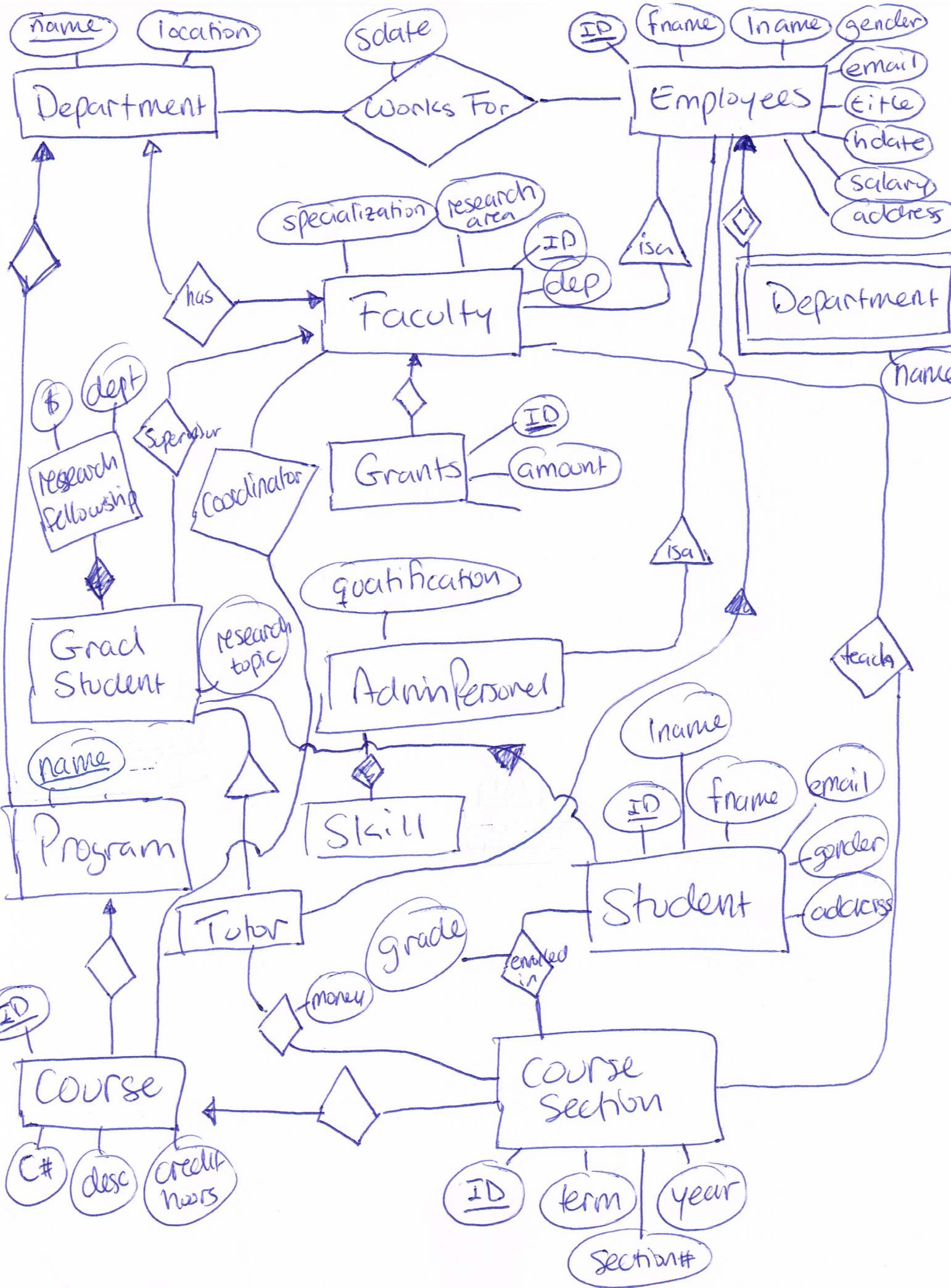
Question 2: ER Modeling (40 Points)

This problem involves an application where one needs to develop a relational database system for a University. The following is the description of information available on the University:

- Information on each department – name, location, and the employees working for the department, chairman for the department, programs offered, courses offered, and students enrolled.
- Information on each employee - employee ID, first name, last name, gender, email, title, working department, hiring date, dependents, salary and address.
- Information on each faculty member – (in addition to employee's information), specialization, research area, research grants, students' supervised, and courses taught.
- Information on administrative personnel - (in addition to employee's information) qualification, special skills.
- Information on each student – student ID, first name, last name, gender, address, email, programs enrolled-in, a detail list on courses (completed and/or registered with whom and term-wise), and grades.
- Information on each graduate student – (in addition to student's information) name of supervisor, research topic, research fellowship (in terms of CND amount per year).
- Information on each tutor, in addition to graduate student's and employee's information, courses term, sections and amount of money received for each course they are tutoring.
- Information on each course - course number, description, credit-hours, prerequisite courses and course coordinator.

With this information, do the following initial steps in your database design process:

1. Develop an ER diagram to represent the conceptual database scheme for the above "enterprise".
2. In the diagram, mark the various constraints (keys, cardinalities of the relationships, etc.). Identify any constraints that are not captured by the ER diagram.
3. Convert your ER diagram into a relational database scheme. Make refinements to your scheme if possible. Identify the primary keys and the foreign keys in the relational schemes, and hence note the referential integrity constraints in the scheme.


name
location
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gender
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Student
Tutor
grade
money
enrolled in
ID
Course
Course Section
C#
desc
credit hours
ID
term
year
Section#

Department (name, location, chair)

Employee (ID, Fname, Lname, g, email, bdate)
Salary, add.

Dependants (EID, name) — EID: employee ID

EWorkFor (EID, DepID, StartDate, EndDate)

Program (name, DepID, description)

Course (C#, description, credit hours, prog name)

Prereq (C#, Prereq C#)

CourseSection (ID, term, year, section#, fac# (teach #))

AdminPersonel (EID, qualification)

Skill (ID, description)

AdminSkill (EID, SkillID)

Faculty (FID, specialization, ResearchArea,)
FID is employee ID

Grant (ID, FID, Amount, Description).

Student (ID, fname, lname, grade, address, email

StudentProgram (SID, Fname)

StudentCourse (SID, SectionID, grade)

GradStudent (SID, researchTopic, supervisorID,) — supervisorID is faculty ID

Fellowship (FID, GSID, description, money)

~~BNSYPTAUC~~

Question 3: Functional Dependencies (40 Points)

You are given a relation scheme R = {B, N, S, Y, P, T, A, U, C} where B = Building, N = Door Number, S = Street, Y = City, P = Postal Code, T = Type, A = Architect, U = Subcontractor and C = Class. Constraints between the attributes can be expressed in the form of the following functional dependencies:

F = {AB → T, A → B, U → C, NS → BTYP, P → Y}.

a) Find all candidate keys of R. Prove that these are the only keys. [5 points]

$NSAU^+ = NSAUBCYPT$ → super key but not minimal.

$N^+ = N \quad A^+ = ABT$

$S^+ = S \quad U^+ = UC$

$NS^+ = NSBTYP \quad NU = NUC$

$NA^+ = NABT$

- The only way to get P is through NS
  The only way to get C is through U
- There is no way to get A, N, S, or U so they must be a part of the candidate key.

∴ Thus {NSAU} is minimal and a candidate key as well.

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BUSYPTAU C CK = USAU

F = {AB → T, A → B, U → C, NS → BTYP, P → Y}.

b) Find a canonical cover G of this set of FDs. [14 points]

① ~~AB → T~~ A → T

A → B

U → C

NS → B

NS → T

NS → Y

NS → P

P → Y

② ~~AB → T~~

$A^+ = ABT$

B is redundant

$B^+ = B$

B is not

A → T can get to (T) w/out B

NS → B: $N^+ = N$, $S^+ = S$ → NS → T: $N^+ = N$, $S^+ = S$

NS → Y: $N^+ = N$, $S^+ = S$ → NS → P: $N^+ = N$, $S^+ = S$

G = {B → T, A → B, U → C, NS → P, P → Y}

~~NS → T~~

~~NS → Y~~

~~NS → P~~

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③ B → T

B^+ of (G - B → T)

$B^+ = B$

A → B: $A^+ = A$

U → C: $U^+ = U$

NS → T: $NS^+ = BYPT$ *redundant, T ∈ NS^+

NS → P: $NS^+ = NSBTY$

NS → B: $NS^+ = NSTYP$

NS → Y: $NS^+ = NSBTPY$ *redundant, Y ∈ NS^+

P → Y: $P^+ = P$

NS → Y: $NS^+ = NSBTPY$ *redundant

∴ F_C = {A → B, U → C, NS → B, NS → P, ~~P → Y~~, ~~B → T~~} NS → T

c) Does a set of FD's have a unique canonical cover? Why? . [3 points]

~~Yes it does.~~

~~Because the F_C found above is minimal~~

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CK = NSAU

d) Find a 3NF decomposition of R that is lossless and dependency preserving. [14 points]

$F_C = \{ A \to B, U \to C, NS \to B, NS \to P, P \to Y, B \to T \}$

$R_0 = BT$	$F_0 = B \to T$
$R_1 = AB$	$F_1 = A \to B$
$R_2 = UC$	$F_2 = U \to C$
$R_3 = NSB$	$F_3 = NS \to B$
$R_4 = NSP$	$F_4 = NS \to P$
$R_5 = PY$	$F_5 = P \to Y$
$R_6 = NSAU$	$F_6 = \{\}$

→ dependency preserving

→ lossless

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e) Is your decomposition in (d) is in BCNF? (explain) [4 points]

No, because $R_1 = \{AB\}$ is not a super key or a part of a super key.

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