

COMP 3005B

Assignment #5

Due: Nov 26

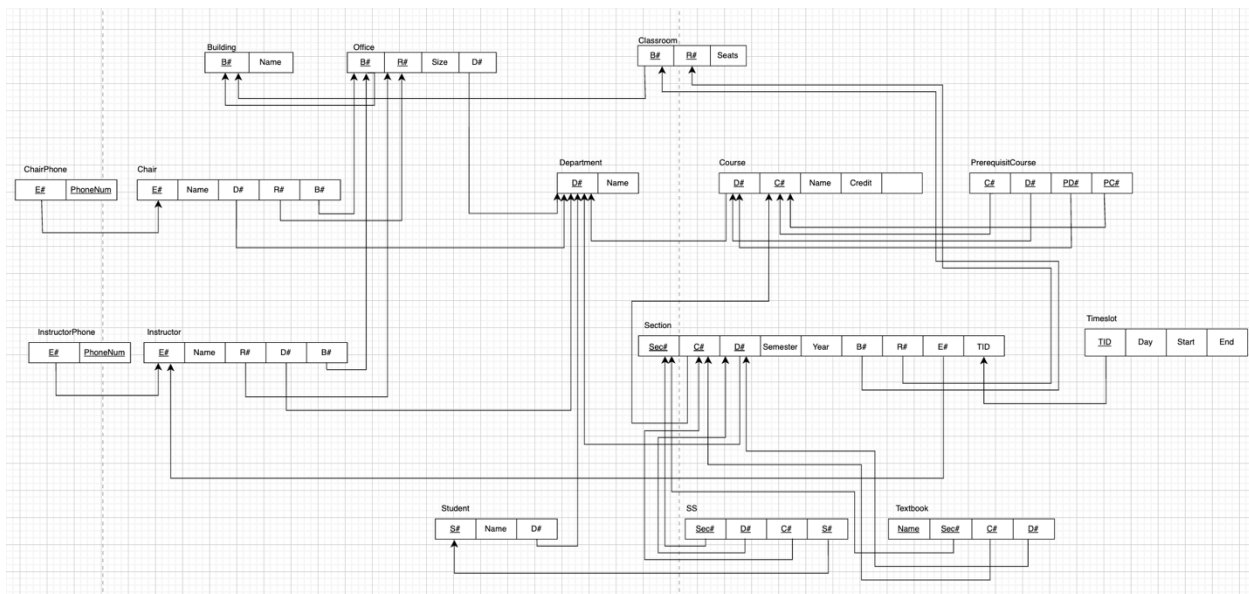
Instruction

1. You should do the assignment independently. If copying is found, the case will be reported to the office of the Dean of Science immediately.
2. Do this assignment directly on this document, rename it with your last name+first name, and submit it to **brightspace**. Make sure your uploaded file can be opened and is correct.

Part 1 ER (10 marks)

Map the generated ER diagram in A4 Part 3 into a relational database schema.

(10)



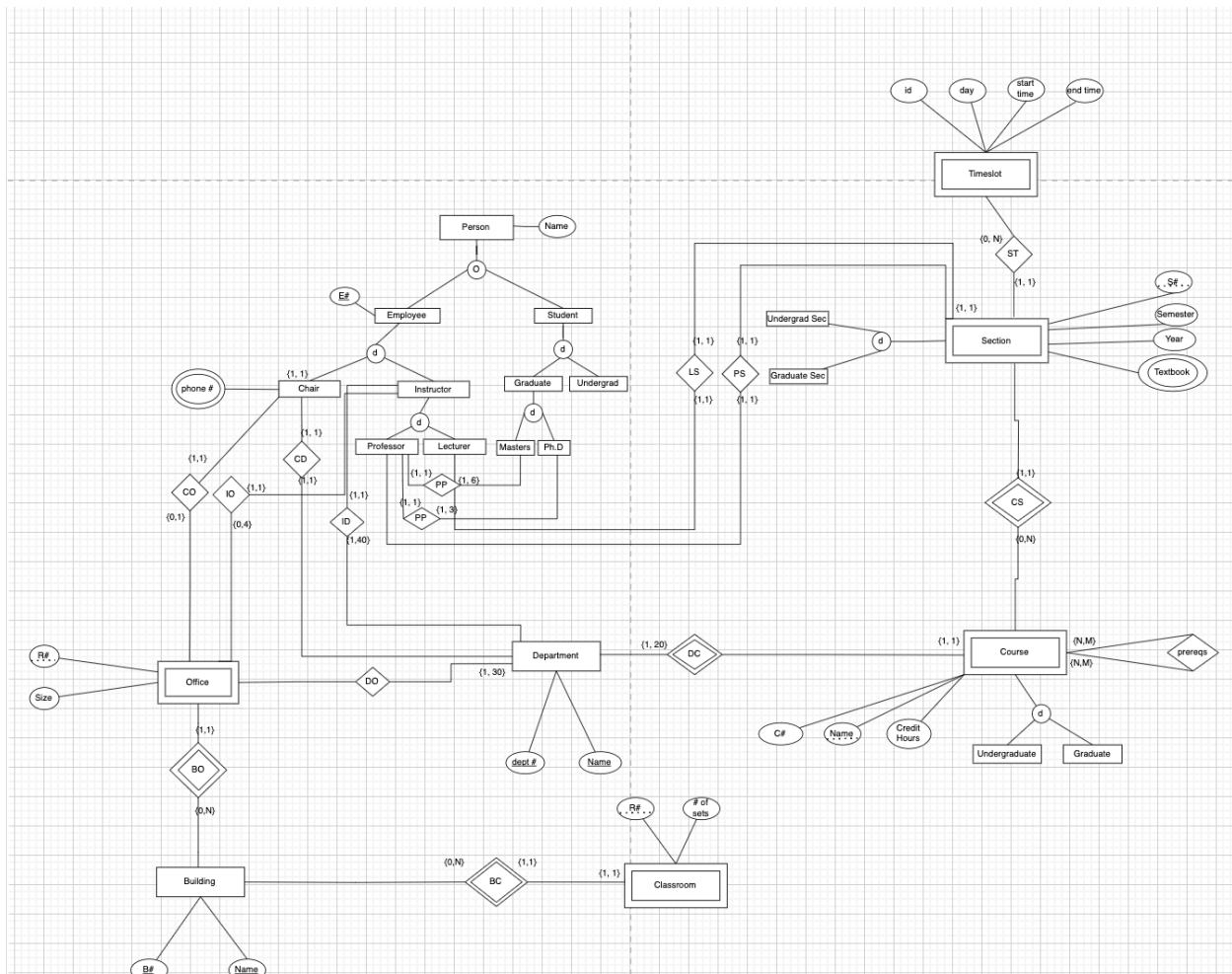
Part 2 EER (40 marks)

Extend the ER Diagram created in A4 Part 3 with the following additional information.

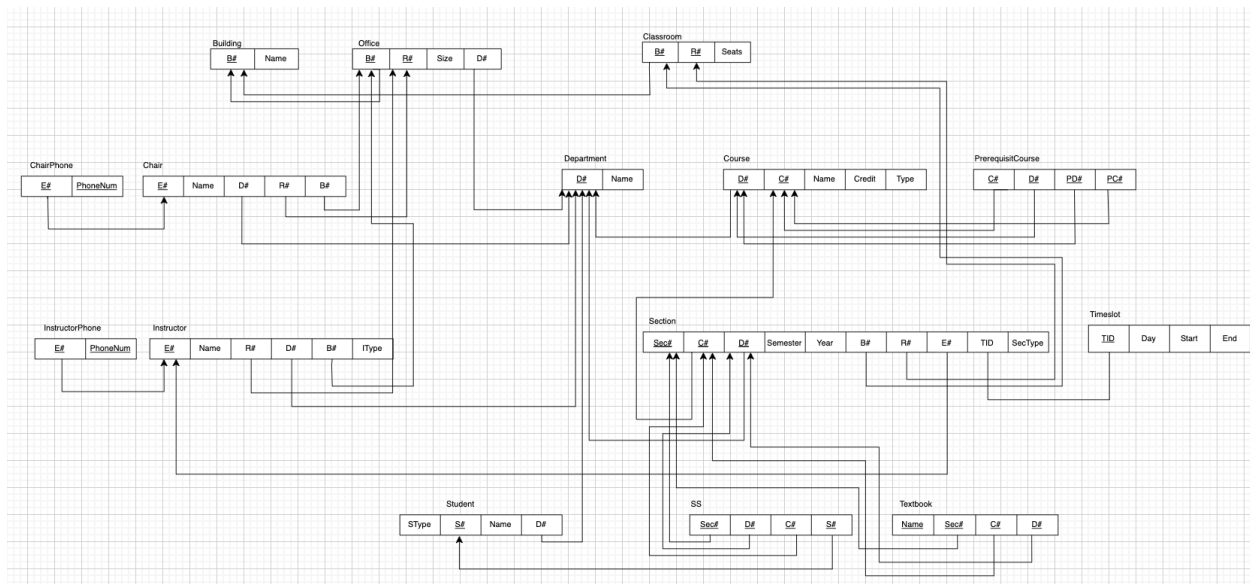
- a) A person is either a student or an employee.
- b) A student is either an undergraduate student or a graduate student. A graduate student is either a Master's student or Ph.D student.
- c) An employee is either a chair, instructor
- d) An instructor is either a professor or a lecturer.
- e) A course is either an undergraduate course or a graduate course
- f) An undergraduate course section is taught by a lecturer and is taken only by undergraduate students

- g) A graduate course section is taught only by a professor and is taken only by graduate students.
- h) A professor also supervises up to 3 Ph.D students and up to 6 Master's students.
2. Draw the EER diagram for this information system that can represent the constraints specified above. (30)
3. Map the EER diagram into a relational database schema. (10)

Updated EER:



Updated Relational Database:



Part 3. FD (10 marks)

- Consider the following relation. Which of the following functional dependencies may hold in this relation? If the dependency cannot hold, explain why by specifying the tuples that cause the violation. (5)

(1) $A \rightarrow B$

No, because there are different values of B that exist for the same A. The first second and last row (a1) all map to different B values so A does not functionally determine B. Tuples: $\langle a1, b1 \rangle$, $\langle a1, b2 \rangle$, $\langle a1, b3 \rangle$

A	B	C
a1	b1	c1
a1	b2	c2
a2	b3	c3
a3	b3	c4
a1	b3	c1

(2) $B \rightarrow C$

No, because there are different values of C that exist for the same B value. The last three rows (b3) all map to different C values so B does not functionally determine C. Tuples: $\langle b3, c3 \rangle$, $\langle b3, c4 \rangle$, $\langle b3, c1 \rangle$

(3) $C \rightarrow B$

No, because there are different values of B that exist

for the same C value. The first and last rows (c1) both map to different B values so C does not functionally determine B. Tuples: $\langle c1, b1 \rangle, \langle c1, b3 \rangle$

(4) $B \rightarrow A$

No, because there are different values of A that exist for the same B value. The last three rows (b3) all map to different A values so B does not functionally determine A. Tuples: $\langle b3, a2 \rangle, \langle b3, a3 \rangle, \langle b3, a1 \rangle$

(5) $C \rightarrow A$

Yes

2. Disprove the following inference rules.

a. $A \rightarrow B, A \rightarrow C \models B \rightarrow C$ (2)

If $A = 1, B = 0, C = 1$

$A \rightarrow B: 1 \rightarrow 0$ (false)

$A \rightarrow C: 1 \rightarrow 1$ (true)

$B \rightarrow C: 0 \rightarrow 1$ (false)

In this counterexample we see that B must be true for C to be but if B is false then C cannot be true. Therefore, this demonstrates that the given inference rule does not hold.

b. $AB \rightarrow C, B \rightarrow D \models C \rightarrow D$ (3)

If $A = 1, B = 1$ and $C = 0, D = 1$

$AB \rightarrow C: 1*1 \rightarrow 0$ (false)

$B \rightarrow D: 1 \rightarrow 1$ (true)

$C \rightarrow D: 0 \rightarrow 1$ (false)

In this counterexample we see that C must be true for D to be true but when C is false this does not hold. Therefore this inference rule is disproven.

Part 4. FD/MVD (10 marks)

Given the following inference rules:

(R0) $X \rightarrow XX$

(R1) if $X \supseteq Y$, then $X \rightarrow Y$

(R2) $X \rightarrow Y \models XZ \rightarrow YZ$

(R3) $X \rightarrow Y, Y \rightarrow Z \models X \rightarrow Z$

Prove or disprove the following inference rules for functional/multi-valued dependencies.

1. $A \rightarrow B, A \rightarrow C \models C \rightarrow B$ (2)

2. $A \rightarrow C, AC \rightarrow B \models A \rightarrow B$ (2)

Applying R0: $A \rightarrow AA$

Applying R2: $X \rightarrow C$ then $AA \rightarrow AC$

Applying R3: $A \rightarrow AA, AA \rightarrow AC, AC \rightarrow B$ then $A \rightarrow C$

3. $A \rightarrow B$ and $C \subseteq B$ and $D \subseteq C \models A \rightarrow D$ (2)

Applying R1: $C \subseteq B$ then $B \rightarrow C$

Applying R1: $D \subseteq C$ then $C \rightarrow D$

$A \rightarrow B, B \rightarrow C, C \rightarrow D$ then $A \rightarrow D$

4. $A \twoheadrightarrow B \models A \rightarrow B$ (2)

Counter example:

A	B
a1	b1
a1	b2

We can see that $A \twoheadrightarrow B$ is true but $A \rightarrow B$ does not since there are different values of b for a1.

5. $A \rightarrow B, C \rightarrow D \models AC \rightarrow BD$ (2)

Applying R2: $A \rightarrow B$ then $AC \rightarrow BC$

Applying R2: $C \rightarrow D$ then $BC \rightarrow BD$

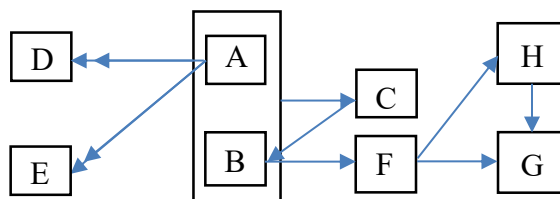
$AC \rightarrow BD, BC \rightarrow BD$ then $AC \rightarrow BD$

Part 5 (30 marks)

Given a first normal form relation **FIRST** with attributes {A, B, C, D, E, F, G, H} with the dependency diagram as follows:

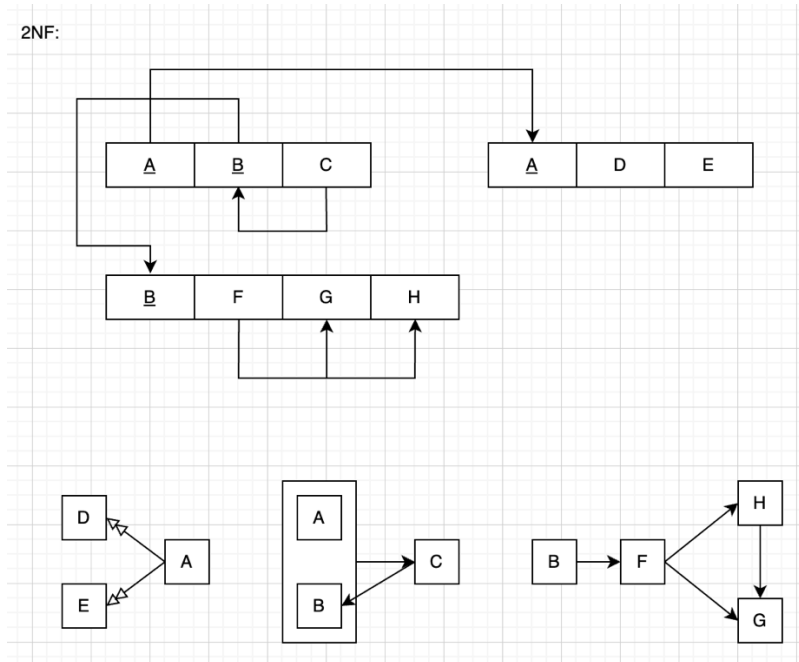
FIRST	A	B	C	D	E	F	G	H
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Dependency Diagram

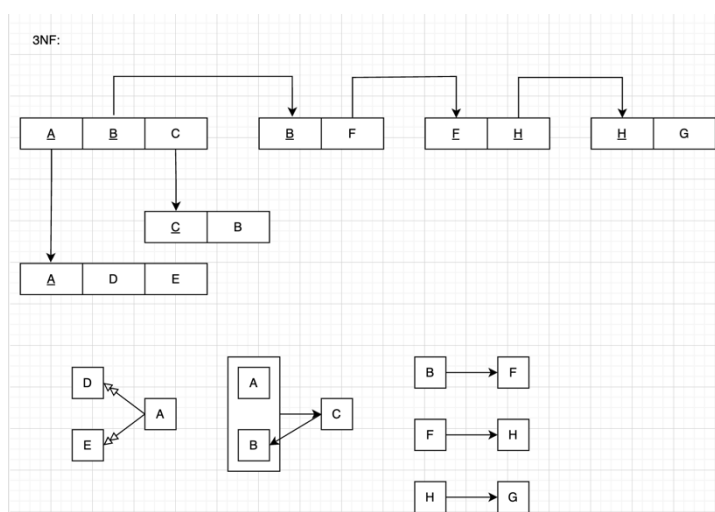


1. What is the key in FIRST? (2)
AB
2. Normalize FIRST into second normal form by giving the relation names, their attributes with primary keys underscored and foreign keys pointing to the corresponding attributes properly and its dependency diagrams as shown above. (10)

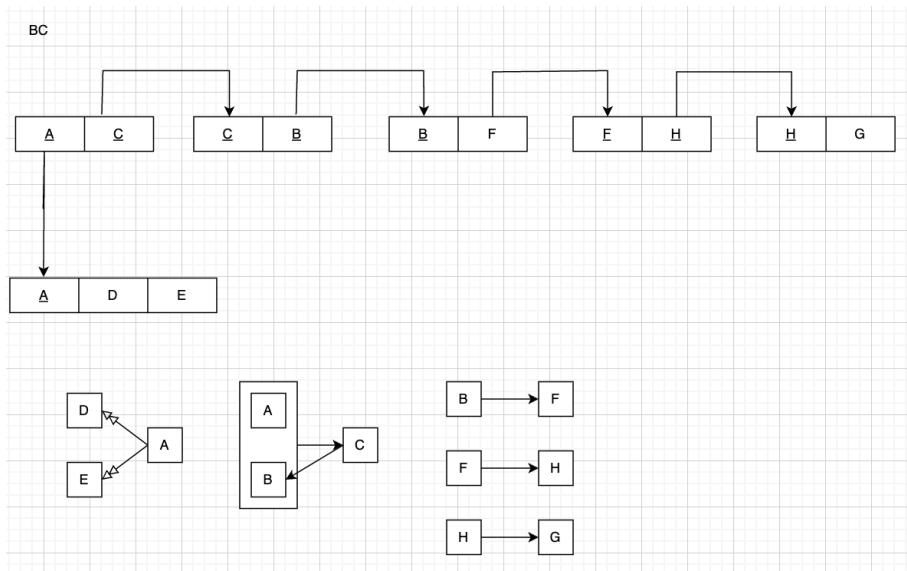
2NF:



3. Normalize the result in 2 into the third normal form by giving the relation names, their attributes with primary keys underscored and foreign keys pointing to the corresponding attributes properly and its dependency diagrams. (10)



4. Normalize the result in 3 into BC normal form by giving the new and related relation names and their attributes with primary keys underscored and foreign keys pointing to the corresponding attributes properly. (4)



5. Normalize the result in 4 into the fourth normal form by giving the new and related relation names and their attributes with primary keys underscored and foreign keys pointing to the corresponding attributes properly. (4)

