COMP 3005
Assignment #6
Due: April 11

Instruction

1. You should do the assignment independently. Copying is not allowed.
2. Submit your assignment as a single word/PDF document on culearn.

Part 1. (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.

A	B	C
10	b1	c1
10	b2	c2
11	b4	c1
12	b3	c4
13	b1	c1
14	b3	c4

1. A → B

   No. <10, b1>, <10, b2>

2. B → C

   Yes

3. C → B

   No <c1, b1>, <c1, b4>

4. B → A

   No <b1, 10>, <b1, 13>, <b3, 12>, <b3, 14>

5. C → A

   No <c1, 10>, <c1, 11>, <c1, 13>, <c4, 12>, <c4, 14>

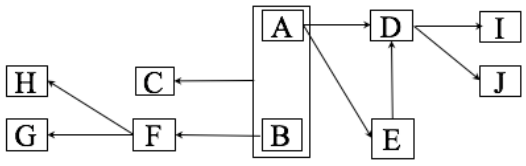
Part 2 (10 marks)

Given a database consisting of one first normal form relation **FIRST** with attributes {A, B, C, D, E, F, G, H, I, J} and the functional dependencies as well as the dependency diagram as follows:

FIRST	A	B	C	D	E	F	G	H	I	J

Functional Dependencies **{AB → C, A → DE, B → F, E→D, F → GH, D → IJ}**

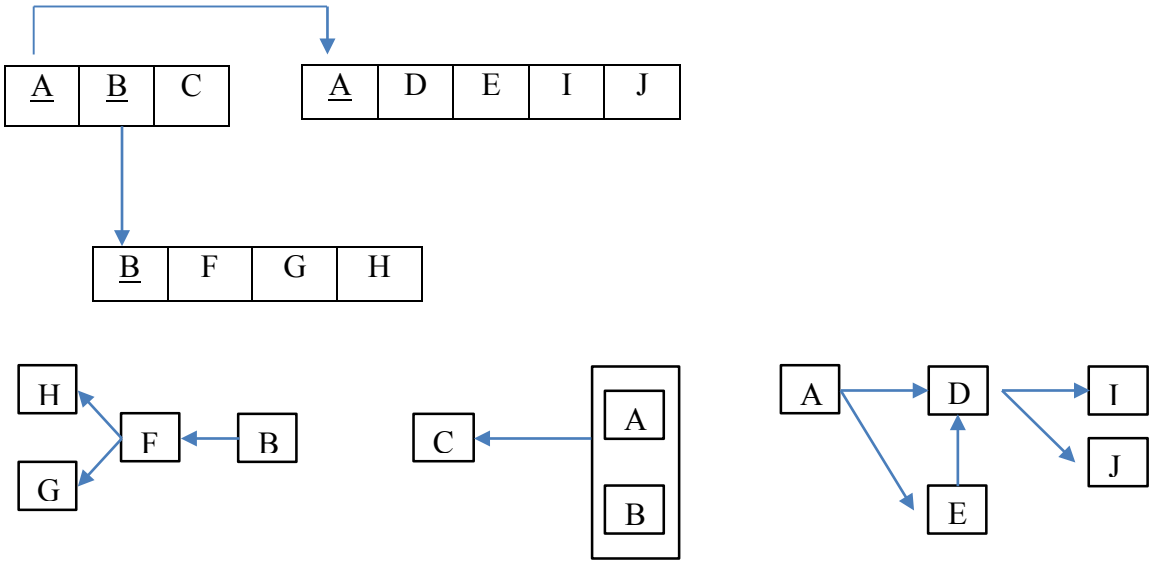
Dependency Diagram



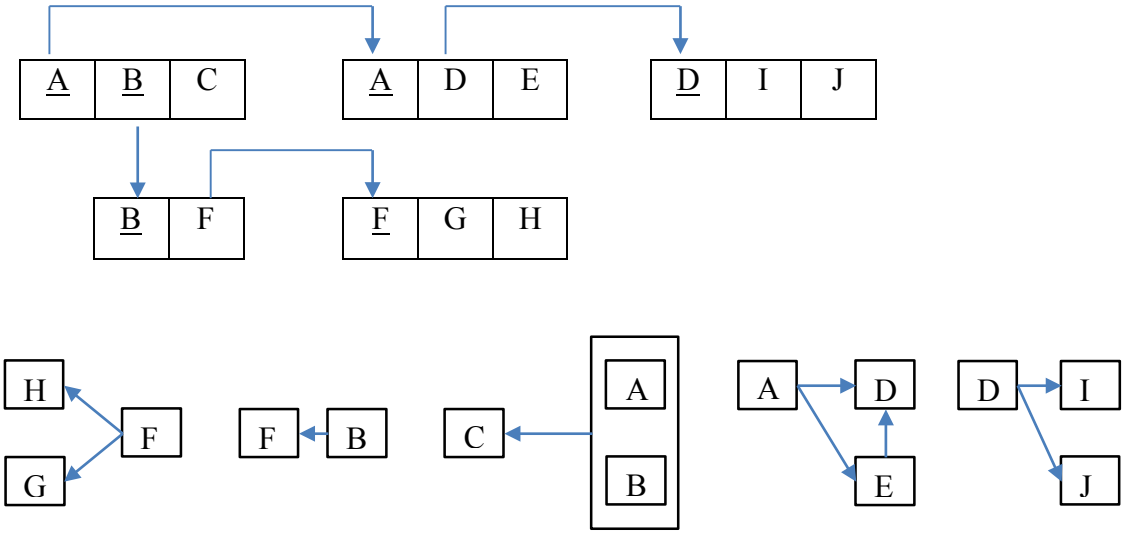
1. What is the key for FIRST? (2 marks)

   AB

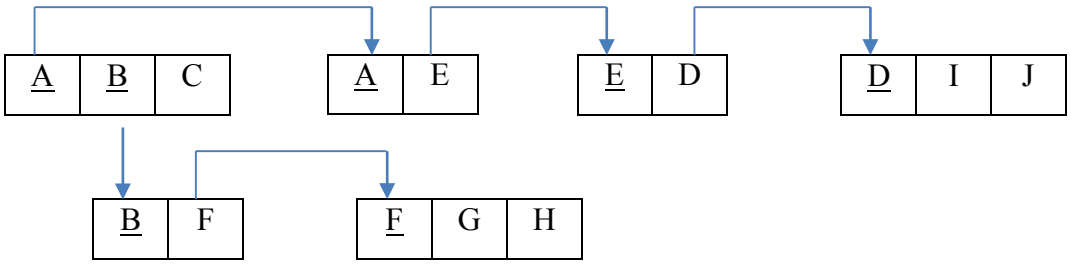
2. Normalize FIRST into second normal form by giving the relation names, their attributes with primary keys underscored and foreign keys pointing to the corresponding attributes properly and its dependency diagrams as showing above (4 marks).

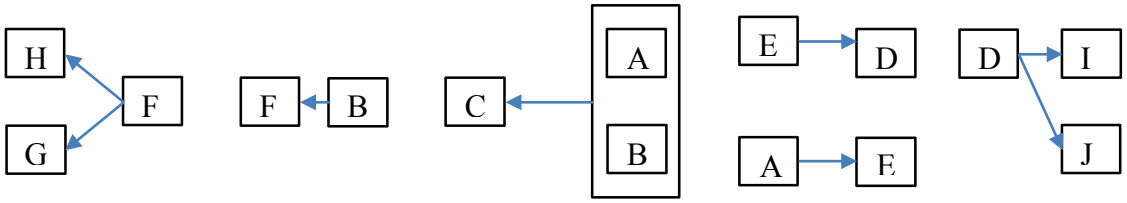


OR



3. Normalize the result in the second question 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 as showing above (4 marks).



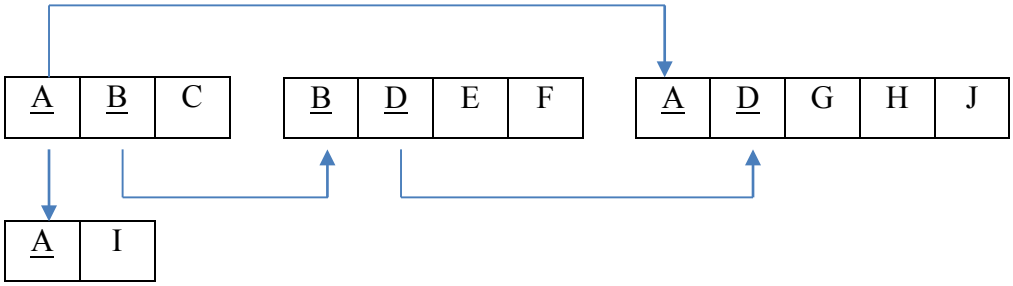


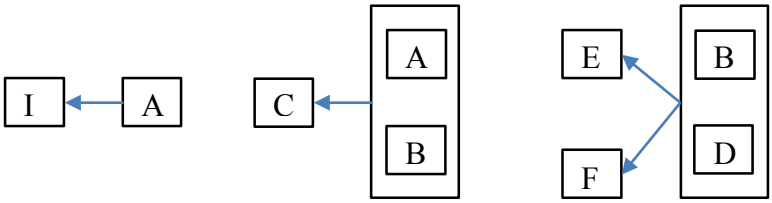
Part 3 (10 marks)

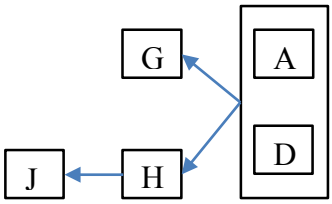
Repeat the questions in Part 2 for the following different set of functional dependencies: **{AB → C, BD → EF, AD → GH, A→I, H → J}.**

1. ABD

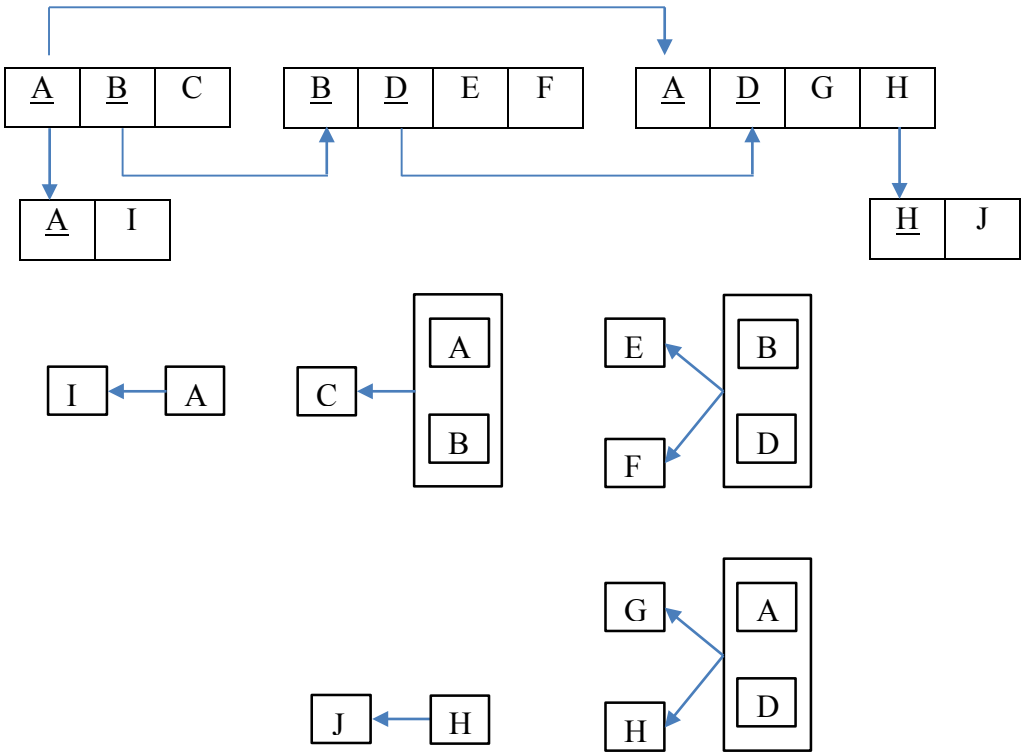
2.







3.



Part 4. (12 marks)

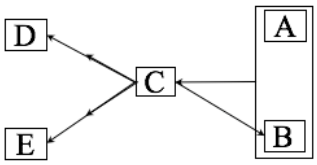
Given a database consisting of one first normal form relation **SECOND** with attributes A, B, C, D, E, and the functional and multi-valued dependencies as well as the functional and the multi-valued dependency diagram as follows:

SECOND	A	B	C	D	E

Functional Dependencies **{AB → C, C → B}**

Multivalued Dependencies {C →→ D, C→→ E}

Dependency Diagram



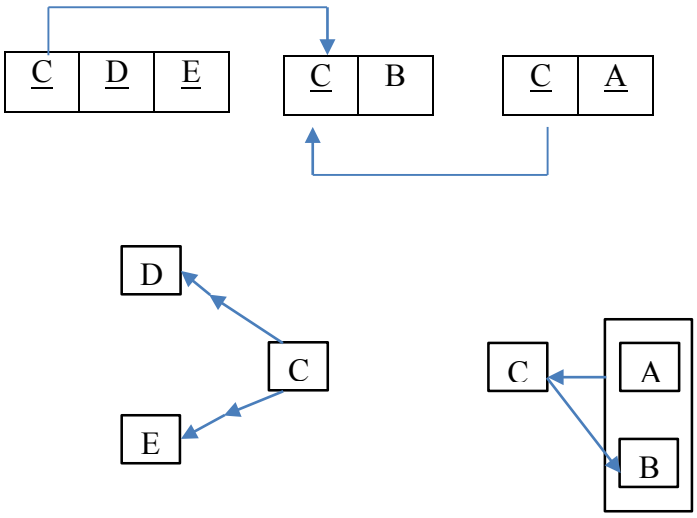
1. What is the key for SECOND? (2 marks)

   ACDE OR ABDE

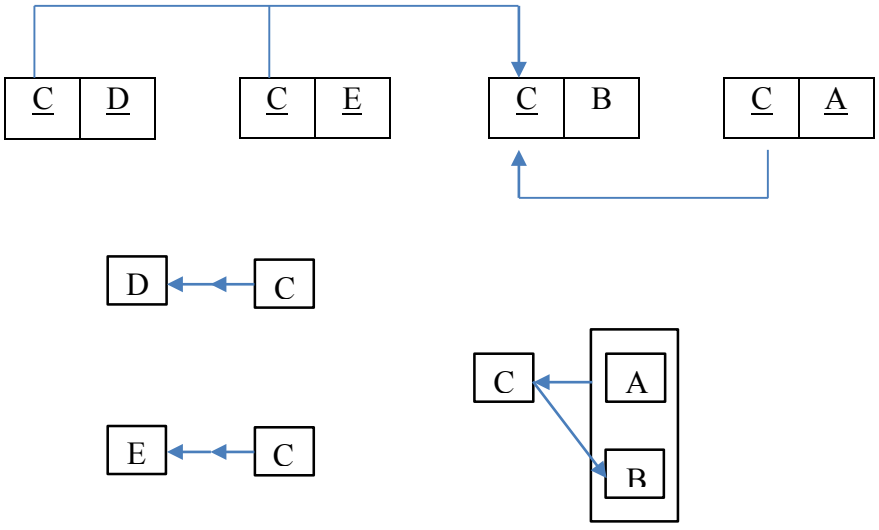
2. What is the highest normal form this relation is in? (2 marks)

   3NF

3. Normalize the relation into BCNF by giving its relation names, their attributes with primary keys underscored and foreign keys pointing to the corresponding attributes properly and its dependency diagrams as showing above (4 marks).



4. Normalize the result in the third question into the fourth normal form by giving its relation names, their attributes with primary keys underscored and foreign keys pointing to the corresponding attributes properly and its dependency diagrams as showing above (4 marks).



Part 5. FD/MVD (10 marks)

Given the following inference rules:
(R0) X → 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. $X \rightarrow Y$ and $Z \subseteq Y$ and $W \subseteq Z \models X \rightarrow W$
2. $X \rightarrow Y, Z \rightarrow Y \models X \rightarrow Z$
3. $X \rightarrow Y, XY \rightarrow Z \models X \rightarrow Z$
4. $X \rightarrow\rightarrow Y \models X \rightarrow Y$
5. $X \rightarrow Y, Z \rightarrow W \models XZ \rightarrow YW$

1. $X \rightarrow Y$ and $Z \subseteq Y$ and $W \subseteq Z \models X \rightarrow W$

$Z \subseteq Y$ then $Y \rightarrow Z$ (R1)

$W \subseteq Z$ then $Z \rightarrow W$ (R1)

$X \rightarrow Y, Y \rightarrow Z, Z \rightarrow W$ then $X \rightarrow W$ (R3)

2. $X \rightarrow Y, Z \rightarrow Y \models X \rightarrow Z$

X	Y	Z
x1	y1	z1
x1	y1	z2

Relation satisfies $X \rightarrow Y, Z \rightarrow Y$, but not $X \rightarrow Z$ since (x1, z1) and (x1, z2)

3. $X \rightarrow Y, XY \rightarrow Z \models X \rightarrow Z$

$X \rightarrow XX$ (R0)

$X \rightarrow Y$ (given) then $XX \rightarrow XY$ (R2)

$X \rightarrow XX, XX \rightarrow XY, XY \rightarrow Z$ then $X \rightarrow Z$ (R3)

4. $X \rightarrow\rightarrow Y \models X \rightarrow Y$

X	Y
x1	y1
x1	y2

Relation satisfies $X \rightarrow\rightarrow Y$, but not $X \rightarrow Y$ since (x1, y1) and (x1, y2)

5. $X \rightarrow Y, Z \rightarrow W \models XZ \rightarrow YW$

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

$Z \rightarrow W$ then $YZ \rightarrow YW$ (R2)

$XZ \rightarrow YZ, YZ \rightarrow YW$ then $XZ \rightarrow YW$