Assignment 4

1. Are the following sets of FDs equivalent? Explain why.
E = {A->C, AC->D, E->AD, EC->DH, DE->CH}
F = {A->CD, E->AH}

E covers F:

$\{A\}^+ = \{A, \underline{\underline{C}}, \underline{\underline{D}}\}$ ✓

$\{E\}^+ = \{E, \underline{\underline{A}}, D, C, \underline{\underline{H}}\}$ ✓

F covers E:

$\{A\}^+ = \{A, \underline{\underline{C}}, D\}$ ✓

$\{AC\}^+ = \{A, C, \underline{\underline{D}}\}$ ✓

$\{E\}^+ = \{E, \underline{\underline{A}}, H, C, \underline{\underline{D}}\}$ ✓

$\{EC\}^+ = \{E, C, A, \underline{\underline{H}}, \underline{\underline{D}}\}$ ✓

$\{DE\}^+ = \{D, E, A, \underline{\underline{H}}, \underline{\underline{C}}\}$ ✓

Since E covers F and F covers E, the two sets are equivalent.

2. Find a 3NF decomposition of a relation R(ABCDEFGHIJ) that satisfies the following FDs: { AB->C, BD->EF, AD->GH, A->I, H->J, GD->ABH }
(follow regular normalization steps and successively normalize to 3NF)

$\{AB\}^+ = \{A, B, C, I\}$

$\{BD\}^+ = \{B, D, E, F\}$

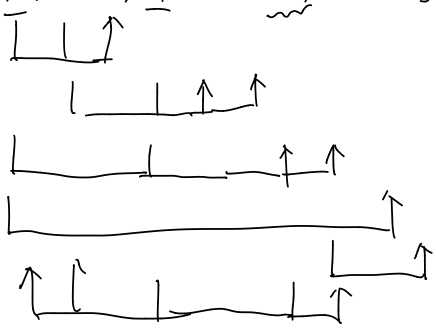
$\{AD\}^+ = \{A, D, G, H, I, J, B, C, E, F\}$ ✓

$\{A\}^+ = \{A, I\}$

$\{H\}^+ = \{H, J\}$

$\{GD\}^+ = \{G, D, A, B, H, C, E, F, I, J\}$ ✓

R(A, B, C, D, E, F, G, H, I, J)



AD and GD can be used as candidate key.

Prime attribute: A, D, G

Since I is partially depend on A, it is not in 2NF.

$\Rightarrow$ 2NF:

R1(A, B, C, D, E, F, G, H, J)

R2(A, I)

FDs that violate 3nf are $AB \to C$, $BD \to EF$, $H \to J$

=> 3NF

R1 (A, B, D, G, H)

R2 (A, I)

R3 (A, B, C)

R4 (B, D, E, F)

R5 (H, J)

3. Find a minimal cover of the following set of dependencies:
{AB->CDE, C->BD, CD-> E, DE->B }

$AB \to C$

$AB \to D$ x

$AB \to E$

$C \to B$

$C \to D$

$CD \to E$

$DE \to B$

$AB \to C$

$AB \to E$

$C \to B$

$C \to D$ $(CC \to CD)$

$CD \to E$

$DE \to B$

$AB \to C$

$AB \to E$ x

$C \to B$

$C \to D$

$C \to E$

$DE \to B$

$AB \to C$

$C \to B$ x

$C \to D$

$C \to E$

$DE \to B$

$AB \to C$

$C \to D$

$C \to E$

$DE \to B$.

minimum cover

4. Consider a relation R(ABCDEFGHIJ) satisfying the following FDs: FI→EHJC H→GB F→EA HI→FGD A→C

(a) Find all candidate keys for R. Show all the steps. List prime attributes of R.

(b) Based on given functional dependencies and candidate keys that you have found, find a 3NF decomposition of R. (follow regular normalization steps and successively normalize to 3NF)

(a).

$\{FI\}^+ = \{F, I, H, J, G, B, E, A, D, C\}$ ✓

$\{H\}^+ = \{H, G, B\}$

$\{F\}^+ = \{F, A, E, C\}$

$\{HI\}^+ = \{H, I, F, D, J, G, B, E, A, C\}$ ✓

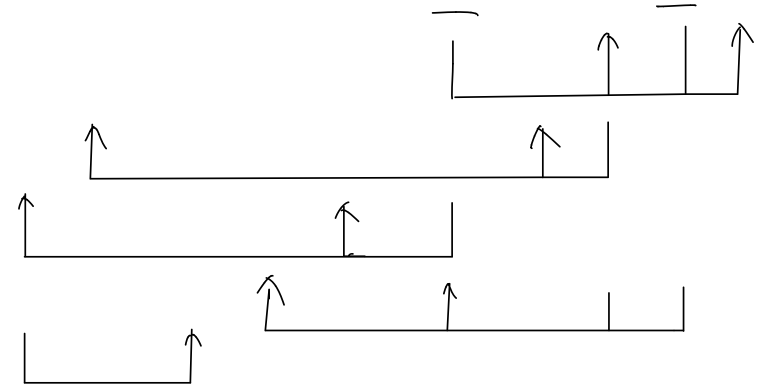
$\{A\}^+ = \{A, C\}$

Since $\{FI\}^+$ and $\{HI\}^+$ can include all attributes

~~the~~ ~~two~~ can be candidate keys.

The prime attribute is H, F, I

b). R(A, B, C, D, E, $\underline{F}$, G, H, $\underline{I}$, J)



Since E, A is partially depend on F, and B, G is partially depend on H, it is not in 2NF.

=> 2NF

R1(A, E, $\underline{F}$, C)

R2(B, G, $\underline{H}$)

R3(D, $\underline{F}$, H, $\underline{I}$, J)

Since $F \to A$ and $A \to C$, it is not in 3NF.

=> 3NF.

R1(A, E, $\underline{F}$)

R2(B, G, $\underline{H}$)

R3(D, $\underline{F}$, H, $\underline{I}$, J)

R4($\underline{A}$, C)

5. Find a lossless (non-additive), dependency preserving 3NF decomposition of R(EFGHI) using the minimal cover method. R satisfies the following dependencies:

FG→E HI→E F→G FE→H H→I

$FG \to E$		$F \to E$		$F \to E$		$F \to E$ ×		$H \to E$
$HI \to E$		$HI \to E$		$H \to E$		$H \to E$		$F \to G$
$F \to G$	→	$F \to G$	→	$F \to G$	→	$F \to G$	→	$F \to H$
$FE \to H$		$FE \to H$		$FE \to H$		$F \to H$		$H \to I$
$H \to I$		$H \to I$		$H \to I$		$H \to I$		minimum cover

$\Rightarrow$ R1($\underline{F}$, G, H)

R2($\underline{H}$, E, I)

6. Consider a relation R(ABCDEFGHIJ) satisfying the following FDs:

DG→CFHB D→CJ F→EA J→B FG→DEI

(a) Find all candidate keys for R. Show all the steps. List prime attributes of R.

(b) Based on given functional dependencies and candidate keys that you have found, find a 3NF decomposition of R. (follow regular normalization steps and successively normalize to 3NF)

a.

$\{DG\}^+ = \{D, G, F, H, C, J, E, A, B, I\}$ ✓

$\{D\}^+ = \{D, C, J, B\}$

$\{F\}^+ = \{F, E, A\}^+$

$\{J\}^+ = \{J, B\}$

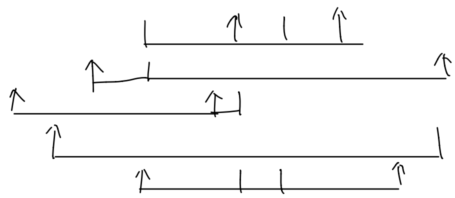
$\{FG\}^+ = \{F, G, D, I, E, A, H, C, J\}$

DG and FG are candidate keys.

prime attribute is D, F, G

b).

R(A B C <u>D</u> E F <u>G</u> H I J)



Since A, E is partially depend on F,
and C, J is partially depend on D, it is
not in 2NF.

$\Rightarrow$ 2NF R1 (A, E, <u>F</u>)
R2 (C, J, <u>D</u>, B)
R3 (<u>D</u>, F, <u>G</u>, H, I)

Since D $\rightarrow$ J and J $\rightarrow$ B, it is
not in 3NF.

$\Rightarrow$ 3NF R1 (A, E, <u>F</u>)
R2 (C, J, <u>D</u>)
R3 (<u>D</u>, F, <u>G</u>, H, I)
R4 (<u>J</u>, B)

7. Find a lossless, dependency preserving 3NF decomposition of R(CDEFG) using the minimal cover method. R satisfies the following dependencies:

F→G D→E DC→F DE→C FG→C

$F \to G$	$F \to G$	$F \to G$	$F \to G$	$F \to G$
$D \to E$	$D \to E$	$D \to E$	$D \to E$	$D \to E$
$DC \to F$	$DC \to F$	$DC \to F$	$D \to F$	$D \to F$
$DE \to C$	$DE \to C$	$D \to C$	$D \to C$ x	$F \to C$
$FG \to C$	$F \to C$	$F \to C$	$F \to C$	minimum cover

$\Rightarrow$ $R1(\underline{F}, C, G)$

$R2(\underline{D}, E, F)$