ComS 363
Homework 2

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1)

(a) A, C, and D should not be used as key, as each has duplicate values in their respective columns.
B should be used as key as it is the only column without duplicate values.

(b) All unique values in C are accompanied by their own corresponding unique values in D, so the dependency is satisfied.
$[3 \rightarrow 4]$, $[8 \rightarrow 5]$

(c) All unique values in C are **not** accompanied by their own corresponding unique values in B, so the dependency is **not** satisfied.
$[8 \rightarrow 3]$, $[8 \rightarrow 7]$

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2)

(a) AG $\rightarrow$ B $\Rightarrow$ BBB $\rightarrow$ BBCD $\Rightarrow$ BBCDD $\sim>$ BDCBD $\rightarrow$ BDCE $\rightarrow$ BDF

(b) $B^+ = \{B, CD, CE, F\}$

(c) **AG** $\rightarrow$ **B** $\Rightarrow$ BB $\rightarrow$ **C**B**D** $\rightarrow$ C**E** $\rightarrow$ **F**
Starting from AG, all of ABCDEFG can be accessed. Thus, AG is a key.

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3)

(a) $\{A \to B, A \to C\}$

(b) $\{ABCD \to E, ABCD \to F\}$

(c) $\{A \to B, A \to C, C \to D\}$

(d) $\{A \to B, A \to C, A \to D\}$

(e) $\{A \to B, ACD \to E, EF \to G, EF \to H\}$

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4)

(a) Disproof:

X	Y	Z
X1	Y1	Z1
X1	Y2	Z3

(b)

1. $X \to YZ$ (given)
2. $X \to Y$ (decomposition) ✓

(c) Disproof:

W	X	Y	Z
W1	X1	Y1	Z1
W1	X2	Y1	Z2

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5)

(a) Computing attribute closure:

$$A \to A \qquad B \to ABCD \qquad C \to CD \qquad D \to D$$
$$AB \to ABCD \qquad AC \to ACD \qquad AD \to AD$$
$$BC \to ABCD \qquad BD \to ABCD \qquad CD \to CD$$
$$ABC \to ABCD \qquad ABD \to ABCD \qquad ACD \to ACD \qquad BCD \to ABCD$$

As all combinations that result in ABCD rely on B, we can conclude that B is the only non-redundant key.

(b) $BC \to ABCD$

(c) $A \to A$

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6)

Calculating attribute closure:
$A \rightarrow A$
$B \rightarrow B$
$C \rightarrow ACD$
$D \rightarrow AD$

$AB \rightarrow ABCD$
$AC \rightarrow ACD$
$AD \rightarrow AD$

$BC \rightarrow ABCD$
$BD \rightarrow ABD$
$CD \rightarrow ACD$

$ABC \rightarrow ABCD$
$ABD \rightarrow ABCD$
$ACD \rightarrow ACD$
$BCD \rightarrow ABCD$

(a) No, because of $C \rightarrow D$ and $D \rightarrow A$

(b) Start: (ABCD)
1. (CAD)(BC) because of $C \rightarrow D$ violation, making C a superkey.
2. (DA)(CD)(BC) because of $D \rightarrow A$ violation, making D superkey.

(c) No, the decomposition does not preserve the $AB \rightarrow C$ dependency.

(d) Start: (ABCD)
1. (ABC)(CD) because of $C \rightarrow D$ violation, making C a superkey.

(e) No, the decomposition does not preserve the $D \rightarrow A$ dependency.