5

1

✓ Answer

```
create or alter trigger updStuCreditOnInsUpd
on takes
after insert, update
as
begin
        if (ROWCOUNT_BIG() = 0) return;
        if exists (
                select grade
                        from inserted as i
                        where (i.grade is not null)
        )
        begin
                set nocount on;
                update student
                        set tot_cred = tot_cred +
                                case
                        when
                                (i.grade not in ('D-','F')
                                                        and
                                                (d.grade IS NULL or
d.grade in ('D-','F')))
                                        then c.credits
                        when
                                (i.grade in ('D-','F')
                                                        and
                                                d.grade not in ('D-
','F')
                                        then -c.credits
                        else 0
                    end
                        from student as s
                        inner join inserted as i
                                on s.id = i.id
                        left join deleted as d
                                on d.id = i.id and d.course_id =
i.course_id
                        inner join course as c
                                on i.course_id = c.course_id;
```

```
        end;
end;
```

2

a

✓ **Answer**

Given: $A \to C, B \to AE, B \to D, BD \to C$

$A \subseteq AE$ by definition
$AE \to A$ by reflexivity
$A \to C$ given
$B \to C$ by transitivity
$B \to D$ given
$B \to BC$ by augmentation
$BC \to CD$ by augmentation
$B \to CD$ by transitivity

b

✓ **Answer**

$B^+ = \{B\}$
$B^+ = \{B, D\}$ by $B \to D$
$B^+ = \{A, B, D, E\}$ by $B \to AE$
$B^+ = \{A, B, C, D, E\}$ by $A \to C$

3

a

✓ **Answer**

Given $R(A, B, C, D, E, F, G)$, $A \to B, B \to CG, C \to FD, D \to E, E \to G$, and
$R_1(A, B, C, F), R_2(D, E, G)$
$R_1 \cap R_2 = \emptyset$
And thus $R_1 \cap R_2$ determines nothing, and is thus lossy.

b

✓ Answer

Given $R(A, B, C, D, E, F, G)$, $A \to BFG, B \to CG, AB \to G, C \to D, D \to E, F \to E$, and $R_1(A, B, C, F), R_2(C, D, E, G)$

$F = R_1 \cap R_2 = C$

$F^+ = C^+$
$\{C\} \subseteq C^+$ by definition
$\{C, D\} \subseteq C^+$ by$C \to D$
$\{C, D, E\} \subseteq C^+$ by$D \to E$

No more can be determined.

Since $R_1 \nsubseteq F^+$ and $R_2 \nsubseteq F^+$, this is not lossless.

c

✓ Answer

Given $R(A, B, C, D, E, F, G)$, $A \to B, B \to C, BC \to F, D \to EG$, and $R_1(A, D, E, G), R_2(A, B, C, F)$

$F = R_1 \cap R_2 = A$

$F^+ = A^+$
$\{A\} \subseteq A^+$ by definition
$\{A, B\} \subseteq A^+$ by $A \to B$
$\{A, B, C\} \subseteq A^+$ by $B \to C$
$\{A, B, C, F\} \subseteq A^+$ by $BC \to F$

Since $R_2 \subseteq F^+$, this decomposition is lossless.

4

a

✓ Answer

Given $R(A, B, C, D, E, F, G, H, I)$ and
$A \to BHI, C \to E, E \to F, BC \to D, F \to G, H \to G, CD \to A$

The following transitivity chains exist:

1. $C \to E \to F \to G$
2. $CD \to A \to BHI \to 1$

3. $BC \to D \to 2$
4. $H \to G$

$ABCDEFGHI^+ = ABCDHI^+$ by 1
$ABCDHI^+ = CD^+$ by 2
CD^+ is minimal.

$ABCDEFGHI^+ = ABCDHI^+$ by 1
$ABCDHI^+ = BC^+$ by 3 and 2
BC^+ is minimal.

Thus, our candidate keys are BC and CD

b

✓ **Answer**

$\{B, C, D\}$ exist as parts of CKs, and thus are prime attributes

5

a

✓ **Answer**

Given $A \to BGHI, C \to EF, E \to F, BC \to ADE, F \to G, H \to G, CD \to A$

$C \to E \implies C \to EF$ as $E \to F$ is also given
$BC \to AD \implies BC \to ADE$ as $C \to E$
$BC \to D \implies BC \to AD$ as $CD \to A$
$A \to BHI \implies A \to BGHI$ as $H \to G$

Which leaves us with:
$BC \to D$
$CD \to A$
$A \to BHI$
$C \to E$
$E \to F$
$F \to G$
$H \to G$

b

✓ Answer

None of the one to one dependencies are repeated, so these all cannot be reduced further.

$A \to BHI$ is irreducible as there are no other relations between B, H, I
$BC \to D$ is irreducible as B, C are unrelated
$CD \to A$ is the same

The validity of the dependencies are proven in part a.

6

a

✓ Answer

Given $R(A, B, C, D, E, F, G, H, I, J, K)$ and $A \to BCD, HI \to J, AEFG \to HIK$

The only irreducible determinants are $A, HI, AEFG$

The only one of those three that determine all of R is $AEFG$

$AEFG \to HIK$
$HI \to J$ as $HIK \to HI$
$AEFG \to BCD$ as $AEFG \to A$

Therefore it is $AEFG$

b

✓ Answer

J only depends on HI, not our key of $AEFG$

c

✓ Answer

$R_1(A, E, F, G, H, I, J, K), R_2(A, B, C, D)$

There is no longer any partial dependency, as BCD only depended on A, not $AEFG$, the key of our R_1

It does not achieve NF3 as J transitively depends on the primary key through HI.

d

✓ **Answer**

$R_1(A, E, F, G, H, I, K), R_2(A, B, C, D), R_3(H, I, J)$

There is no longer any transitive dependency, as J was moved into another table.

This is also in BNCF as all columns directly depend on the super key, additionally no non-prime attributes can determine any prime attributes.

e

✓ **Answer**

For our first decomposition
$R_1 \cap R_2 = A$
In R_2, $A \rightarrow BCD$
$A^+ = \{A, B, C, D\} = R_2$
And thus this decomposition is lossless.

For the second decomposition
$R_1 \cap R_3 = HI$
In R_3, $HI \rightarrow J$
$HI^+ = \{H, I, J\} = R_3$
And thus this decomposition is also lossless.

f

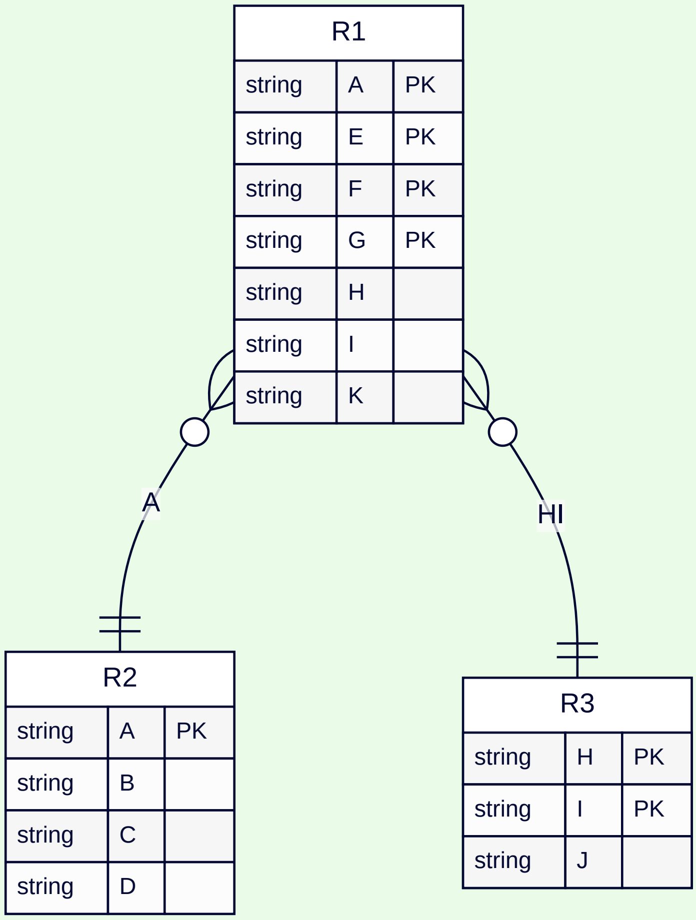
✓ **Answer**

Yes
$A \rightarrow BCD$ is within R_2
$HI \rightarrow J$ is within R_3
$AEFG \rightarrow HIK$ is within R_1

All dependencies are conserved.

g

✓ **Answer**



h

Answer

Given $J \rightarrow I$ and $R_1(A, E, F, G, H, I, K), R_2(A, B, C, D), R_3(H, I, J)$

$R_1(A, E, F, G, H, J, K), R_2(A, B, C, D), R_4(J, I)$

Since HI determines J, R_1 is able to be changed to this.

Since J on its own is able to determine I, we no longer need $HI \rightarrow J$ in R_3