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## Question 1

```
{SSN}+ = {SSN, Ename, Bdate, Address, Dnumber, Dname, Dmgr_ssn}
{Dnumber}+ = {Dnumber, Dname, Dmgr_ssn}
```

## Question 2

A set `G` is not minimal, since dependencies in `G` on RHS have more than one attribute

Minimal set:

```
G' = {
  SSN -> Ename,
  SSN -> Bdate,
  SSN -> Address,
  SSN -> Dnumber,
  DNumber -> Dname,
  DNumber -> Dmgr_ssn
}
```

Proof:

```
G+ = {SSN, Ename, Bdate, Address, Dnumber, Dname, Dmgr_ssn}
G'+ = {{SSN}+, {Dnumber}+}
    = {SSN, Ename, Bdate, Address, Dnumber, Dname, Dmgr_ssn. {DNumber}+}
    = {SSN, Ename, Bdate, Address, Dnumber, Dname, Dmgr_ssn}

Therefore G = G'
```

## Question 3

1. Primary key is `AB`:

```
A -> {D, E} => A -> D and A -> E
A -> D and D -> {I, J} => A -> {I, J}
```

```
Therefore, A -> {D, E, I, J}

{A, B} -> {B, D, E, I, J}
Given {A, B} -> C and {A, B} -> {B, D, E, I, J}, {A, B} -> {B, C, D, E, I, J}
By augmentation, {A, B} -> {A, B, C, D, E, I, J}

Since B -> F and F -> {G, H},
    we can say B -> {G, H} and therefore {A, B} -> {A, G, H}
Given B -> F, {A, B} -> {A, F} holds too

Therefore, {A, B} -> {A, B, C, D, E, F, G, H, I, J}
```

2. Decomposition of `R`

2NF:

```
R1 = {A, B, C}
R2 = {A, D, E, I, J}
R3 = {B, F, G, H}
```

3NF:

```
R1 = {A, B, C}
R2 = {D, I, J}
R3 = {A, D, E}
R4 = {B, F}
R5 = {F, G, H}
```

# Question 4

## a

Decomposition has lossless preservation property and dependency preservation property. Each relation in BCNF

## b

Decomposition has lossless preservation property and dependency preservation property. R1 is 1NF, R2 is 2NF, R3 is BCNF

C

Decomposition does not have lossless join preservation property and no dependency preservation property. R1 is in 1NF, R2 is in 1NF, R3, R4, and R5 are in BCNF