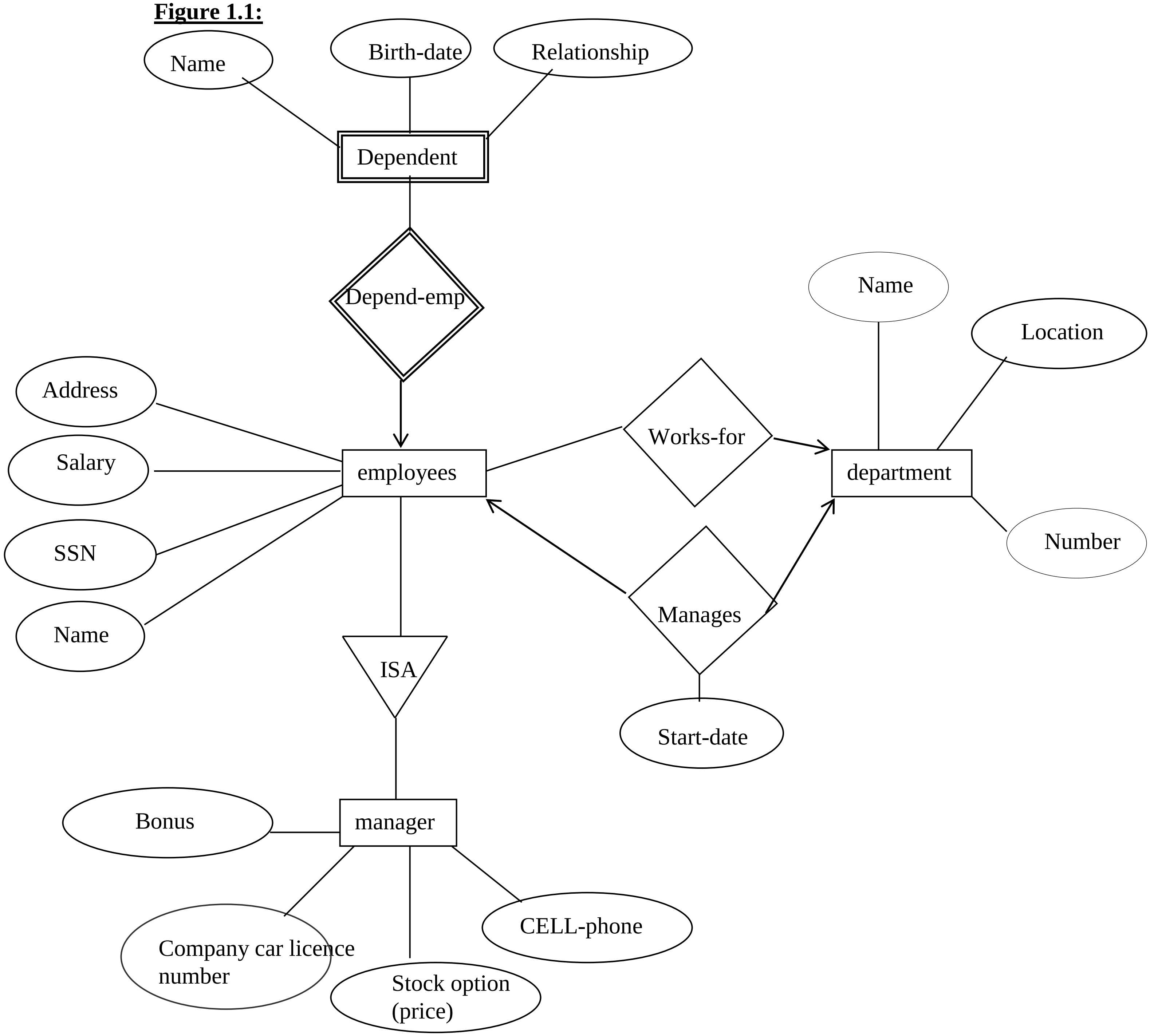
Figure 1.2

Create table Patient (SSN varchar(4) not null unique, Name varchar(15) not null, Insurance int(1), Date_admitted date, Date_checkout date, Primary key(SSN))

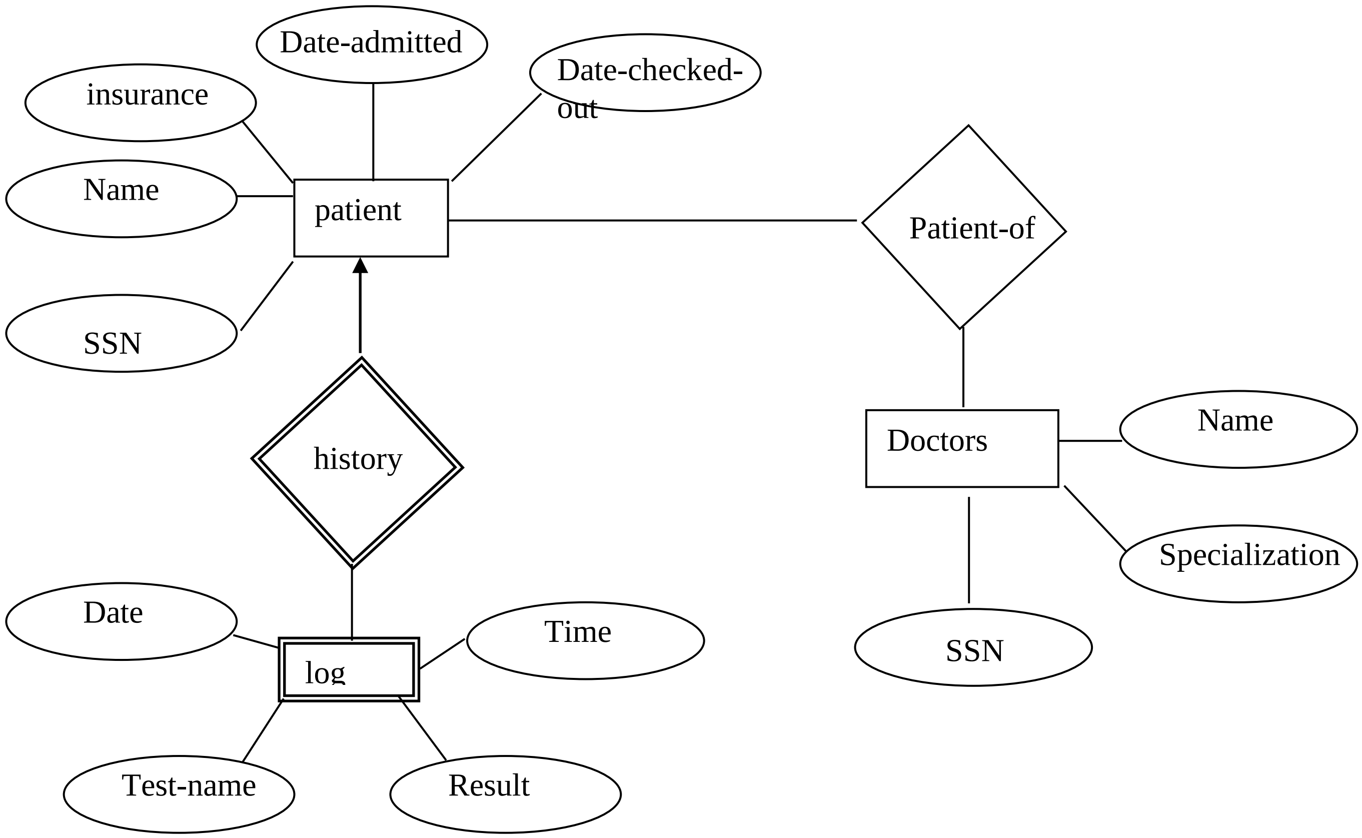
Create table Log(SSN varchar(4) not null unique, Date date not null, Time time not null, Result varchar(50), Primary key (SSN, Date, Time), Foreign key SSN (reference SSN Patient))

Figure 1.1:



1.(cont.) Answer the questions given in 1. b.), c.), d.). for this diagram if you have not answered the questions for the previous diagram **(1a. must be answered for the E-R diagram on the previous page!!)**

Figure 1.2:



****

FROM PROBLEMS 2, 3, 4, 5 YOU NEED TO GATHER JUST 10 POINTS (the total is 17) Any answer up to 7 point may be skipped.
NO EXTRA POINTS ARE GIVEN!!!! INDICATE CLEARLY WHICH YOU HAVE GRADED

2. Which of the following statements are true (2 points)

2.1 Each superkey is a superset of some candidate key.

2.2 Each primary key is also a candidate key, but there may be candidate keys that are not primary keys (circle one answer below).

a) only 2.1 is true

b) only 2.2 is true

c) both 2.1 and 2.2 are true

d) neither 2.1 nor 2.2 are true

---

3. The following questions refer to the instances of relation R(A,B,C,D,E) shown below : (3 points)

A	B	C	D	E
7	4	1	2	3
1	5	3	1	1
1	6	3	2	4
5	5	1	2	3

Which of the following FDs hold over the instance of relation R given above? Answers: I) ABC $\rightarrow$ E II) CD $\rightarrow$ EB III) B $\rightarrow$ D

ANSWERS (CIRCLE ONE!) :

a) I & III

b) II & III

c) I & II

d) I only

e.) OTHER THAN a.), b.), c.), d.)

FROM PROBLEMS 2, 3, 4, 5 YOU NEED TO GATHER JUST 10 POINTS (the total is 17) Any answer up to 7 point may be skipped.
NO EXTRA POINTS ARE GIVEN!!!! INDICATE CLEARLY WHICH YOU HAVE GRADED

4. Consider a relation scheme R(P,M,L,Q,N) with the FD's :
$M \rightarrow Q$, $PM \rightarrow L$, $QN \rightarrow P$
What are the keys of R? (4 points)

ANSWERS (CIRCLE ONE BELOW):

a) {P,M,N} & {M,Q,N}

b) {P,M,Q,N}

c) {M,N}

d) {P,M} & {Q,N}

e.) OTHER THAN a.), b.), c.), d.)

FROM PROBLEMS 2, 3, 4, 5 YOU NEED TO GATHER JUST 10 POINTS (the total is 17). Any answer up to 7 point may be skipped.
NO EXTRA POINTS ARE GIVEN!!!! INDICATE CLEARLY WHICH YOU HAVE GRADED

5. **The following two questions refer to the relational scheme**
R (A, B, C, D, E , F, G, H) and the following functional dependencies over R:
F:={A → BCD, AD → E, EFG → H, F → GH}

5.1 Based on the functional dependencies, there is one candidate key for R. What is it ? Explain why. (3 points)

From the functional dependences, if we suppose the AF is a super key for R,

AF^+ = {A, B, C, D, E, F, G, H}
AF^+ contains every element in R, so AF is a super key. Next to check if AF is minimal,

A^+ = {A, B, C, D, E}
F^+ = {F, G, H}

So, AF is minimal, it is a candidate key for R.

5.2 Give 3 superkeys of R. (3 point)

AF
AFD
AFC
AFCD
.
.
.
.

5.3: One of the four functional dependencies can be removed without altering the key. Which one? (2 points)

EFG → H
****

6. **R (A, B, C, D, E , F, G, H) and the following functional dependencies over R:**
F:={A → BCD, AD → E, EFG → H, F → GH}
Decide and explain why or why not this relation is in Second Normal Form. If it is not, give a lossless 2NF decomposition. (5 points)

AF is the CK (see previous solution).

The relation is not the Second Normal Form because there are partial functional dependencies, for example F→GH, A→BCD.

R can be decomposed,

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

R (A, B, C, D, E, F, G, H) → R2(A, E, F, G, H)

R2(A, E, F, G, H) → R3 (F, G, H)

R2(A, E, F, G, H) → R4(AEF)

R4 (A, E, F)

R4(AEF) → R5 (AE)

R4(AEF) → R6(AF)

For R2 you need to prove, what are the CKs. So prove, that EFG is a CK.

After decomposition, the relations are :

R1, R3, R5, R6

7. The following instances of R and S are given:

R

A	B	C
1	1	3
1	2	1
2	3	2
3	1	2
3	2	3

S

B	C	D	E
1	3	1	2
2	1	2	3
2	3	3	1
3	2	1	1

Give the results of the following relational algebraic expressions! (2+2+3 pont)

7.1 $\pi_{A,E}(\sigma_{C>D}(R \bowtie S))$

A	E
1	2
2	1

7.2 $\pi_{A,F}(\sigma_{A>=F \text{ AND } G>F}(\rho_{P(A,F,G)}(\pi_{A,D,E}(R \bowtie S))))$

A	F
1	1

7.3 Rewrite 7.1 into SQL

```
Select R.A, S.E
From R, S
Where R.B=S.B and R.C = S.C and R.C > S.D
```

8. The schema of a company database is as folllows:

EMP(EMPNO, ENAME, JOB, MGR, HIREDATE, SAL, COMM, DEPTNO)
DEPT(DEPTNO, DNAME, LOC)

EMP=employee, EMPNO= employee identification number,
ENAME= employee name MGR= the boss' employee identification number,
SAL= salary , COMM= comission,
DEPT= department DNAME= department name ,
DEPTNO=department identification number, LOC= location

Give an SQL query for finding

8.1 the names and salaries of those clarks, whose salaries is greater than 1000 dollars but smaller than 2000. (2 point)

```
Select ENAME, SAL
From EMP
Where Job ='clerk' and SAL> 1000 and SAL<2000
```

8.2 the employees' names, salaries together with the name of department they work for. We prefer to have the names in decreasing order with respect to the salary. (3 points)

```
Select EMP.EMPNO, EMP.SAL, DEPT. DNAME
From EMP, DEPT
Where EMP.DEPTNO=DEPT.DEPTNO
Order by EMP.SAL DESC
```

8.3 Find the department (by its number) in which the average salary is greater than the one in department 30. (3 points)

```
Select DEPTNo
From EMP
Group by DEPTNO
Having Avg(SAL) > (Select Avg(SAL)
                   From EMP
                   Where DEPTNO=30 )
```

8.4 What is the result of the following SQL query? Analize and explain. (It does not run in mysql, but it runs in Oracle, etc.) (3 points)

```
SELECT    E.EMPNO, E.ENAME, M.ENAME BOSS
FROM      EMP E, EMP M
WHERE     E.MGR=M.EMPNO;
```

This query selects each employee number, employee name and the name of his boss in the database.

YOUR CHOICE!! YOU MAY SOLVE PROBLEM 9a, or 9b, but NOT BOTH! ONLY ONE WILL BE MARKED! INDICATE CLEARLY WHICH IS YOUR CHOICE!
MAX 5 POINTS ARE GIVEN!

9. a. What are Armstrong axioms? State them (2 points), prove the correctness of any of them (3 points)

Reflexivity Rule --- If *X* is a set of attributes and *Y* is a subset of *X*, then ***X* -> *Y*** holds
Proof:

Assume ∃ *t*1, *t*2 such that $t1[\alpha] = t2[\alpha]$
$t1[\beta] = t2[\beta]$ since $\beta \subseteq \alpha$
Hence $\alpha \rightarrow \beta$

Augmentation Rule --- If ***X* -> *Y*** holds and *W* is a set of attributes, then ***WX* -> *WY*** holds

Proof:

Assume ∃ t1, t2 such that t1 [$\gamma\ \alpha$] = t2 [$\gamma\ \alpha$], then

t1 [γ] = t2 [γ] since $\gamma \subseteq \gamma\ \alpha$ ------ (1)
t1 [α] = t2 [α] since $\alpha \subseteq \alpha\ \gamma$
t1 [β] = t2 [β] (definition of $\alpha \rightarrow \beta$) ------ (2)
t1 [$\beta\gamma$] = t2 [$\beta\gamma$] from (1) and (2)

Hence, $\gamma\ \alpha \rightarrow \gamma\ \beta$

Transitivity Rule --- If ***X* -> *Y*** and ***Y* -> *Z*** hold, then ***X* -> *Z*** holds.
Assume ∃ *t*1, *t*2 such that *t1* [α] = *t2* [α]

Then *t1* [β] = *t2* [β] (definition of $\alpha \rightarrow \beta$)
Hence, *t1* [γ] = *t2* [γ] (definition of $\beta \rightarrow \gamma$)

Therefore, $\alpha \rightarrow \gamma$

9.b Prove or disprove the following derivation rule:
IF $\alpha \rightarrow \beta$ and $\gamma \rightarrow \delta$ (BOTH) hold on a relation instance r, then $\alpha\gamma \rightarrow \beta\delta$ also hold on that instance.

9.b

SOLUTION 1:

Given $\alpha \rightarrow \beta$,

so $\alpha\gamma \rightarrow \beta\gamma$ by augmentation. THAT IS $\alpha\gamma \rightarrow \beta$, $\alpha\gamma \rightarrow \gamma$ using decomposition.

Because $\gamma \rightarrow \delta$, transitivity can be applied:

$\alpha\gamma \rightarrow \gamma$, $\gamma \rightarrow \delta$, which results in $\alpha\gamma \rightarrow \beta\delta$.

Therefore, if $\alpha \rightarrow \beta$ and $\gamma \rightarrow \delta$ then $\alpha\gamma \rightarrow \beta\delta$ holds.

SOLUTION 2:

Given $\alpha \rightarrow \beta$, so $\alpha\gamma \rightarrow \beta\gamma$ by augmentation.

Given $\gamma \rightarrow \delta$, so $\beta\gamma \rightarrow \beta\delta$ by augmentation.

Applying transitivity for $\alpha\gamma \rightarrow \beta\gamma$, $\beta\gamma \rightarrow \beta\delta$ we get $\alpha\gamma \rightarrow \beta\gamma$, $\beta\gamma \rightarrow \beta\delta$

Therefore, if $\alpha \rightarrow \beta$ and $\gamma \rightarrow \delta$ then $\alpha\gamma \rightarrow \beta\delta$ holds.