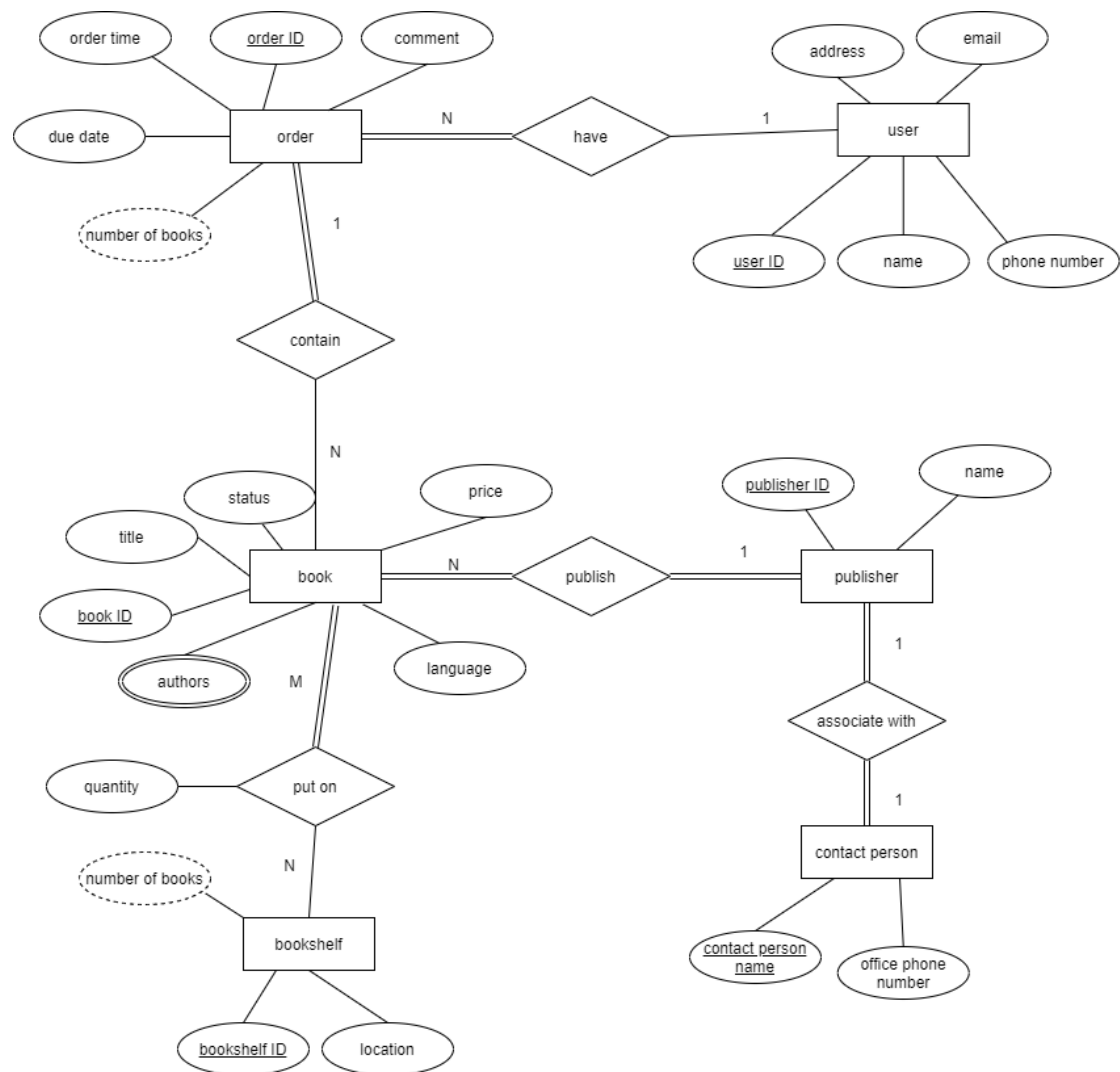
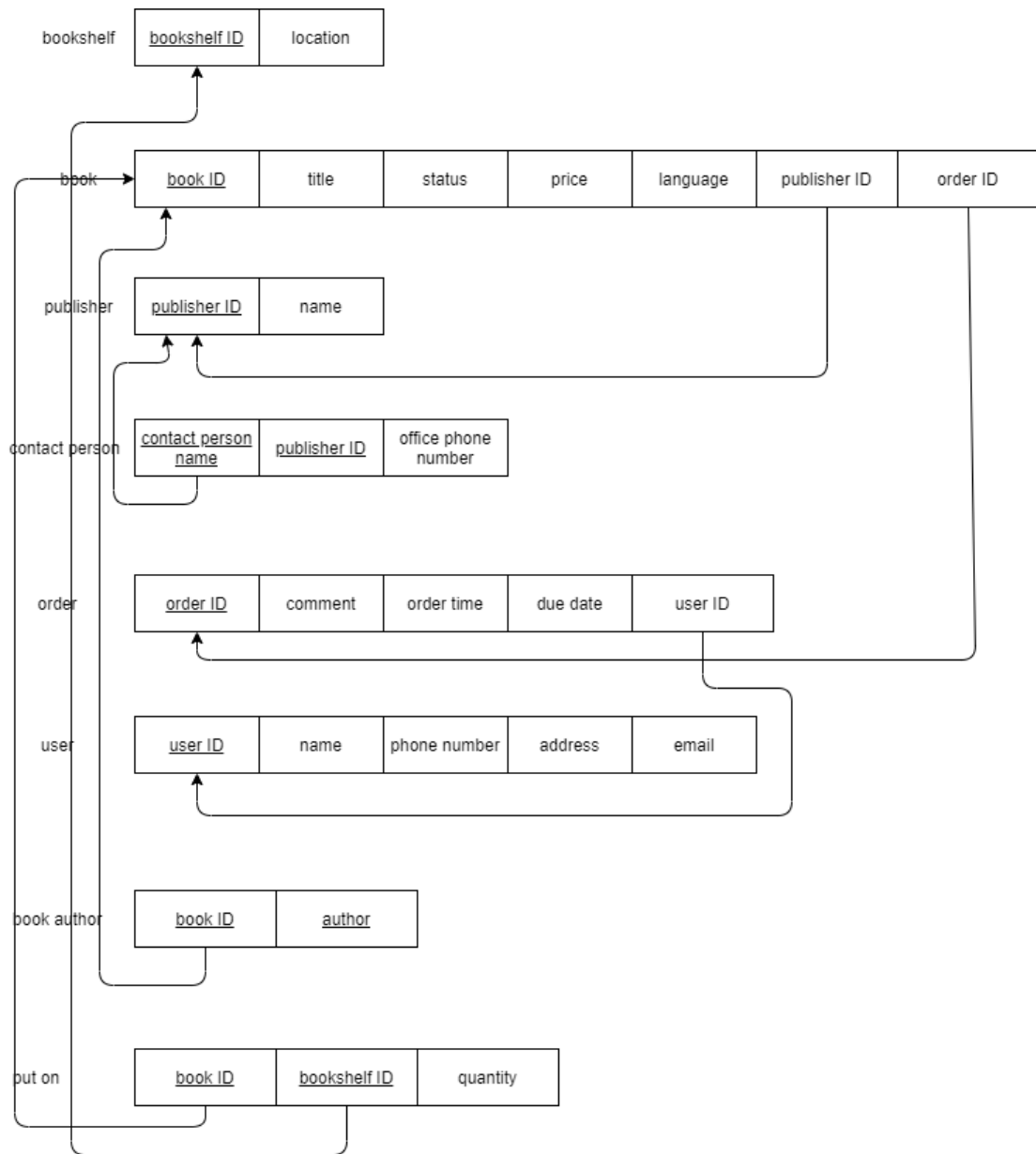


Question 1

(a)



(b)



Question 2

1. $F_m = \{B \rightarrow C, B \rightarrow H, BD \rightarrow I, I \rightarrow H, H \rightarrow A, H \rightarrow B, I \rightarrow E\}$

2. DGB, DGI, DGH

3. not lossless-join, nothing changed

Decomposition	A	B	C	D	E	G	H	I
R ₁ (ABCD)	a	a	a	a	b	b	b	b
R ₂ (DEGHI)	b	b	b	a	a	a	a	a

4. 1NF, not-prime attribute A is functionally determined by H.

$F = \{B \rightarrow CH, BCD \rightarrow HI, EI \rightarrow H, H \rightarrow AB, I \rightarrow E\}$

$F_m = \{B \rightarrow C, B \rightarrow H, BD \rightarrow I, I \rightarrow H, H \rightarrow A, H \rightarrow B, I \rightarrow E\}$

$R = \{A, B, C, D, E, G, H, I\}$

Consider $B \rightarrow C$, $R_0 = \{\underline{B}, C\}$, $R' = \{A, B, D, E, G, H, I\}$

Consider $B \rightarrow H$, $R_1 = \{\underline{B}, H\}$, $R'' = \{A, B, D, E, G, I\}$

Consider $BD \rightarrow I$, $R_1' = \{B, D, I\}$, $R''' = \{A, B, D, E, G\}$

Consider $I \rightarrow H$, $H \rightarrow B$, $R_2 = \{B, \underline{I}\}$, $R_3 = \{D, \underline{I}\}$

Consider $BD \rightarrow I$, $I \rightarrow H$, $H \rightarrow A$, $H \rightarrow B$, $I \rightarrow E$, $R_4 = \{A, \underline{B}, \underline{D}\}$, $R_5 = \{\underline{B}, \underline{D}, E\}$,

$R_6 = \{B, D, G\}$

One of the possible lossless-join decompositions is: $R_0 \sim R_6$

Question 3

1. $R_1 \leftarrow \pi_{\{pID\}} (Park \bowtie Visit \bowtie \sigma_{\{age < 65\}} Visitor)$

$R_2 \leftarrow \pi_{\{pID\}} (Park \bowtie Visit \bowtie \sigma_{\{age > 24\}} Visitor)$

$R_3 \leftarrow \pi_{\{pID\}} (Park)$

$R_3 \leftarrow (R_3 - R_1) \cup (R_3 - R_2)$

2. $\pi_{\{vID\}} (Visit \div \pi_{\{pID\}} (Park))$

3. $R_1 \leftarrow \pi_{\{pID, location\}} (\sigma_{\{name = 'Daniel'\}} Visitor \bowtie Park \bowtie Visit)$

$R_2 \leftarrow \pi_{\{pID, location\}} (\sigma_{\{name = 'James'\}} Visitor \bowtie Park \bowtie Visit)$

$$R_3 \leftarrow (R_1 - R_2) \cup (R_2 - R_1)$$

$$4. R_1 \leftarrow (Visitor \bowtie_{\sigma_{\{location = 'Hyde Park'\}}} (Park))$$

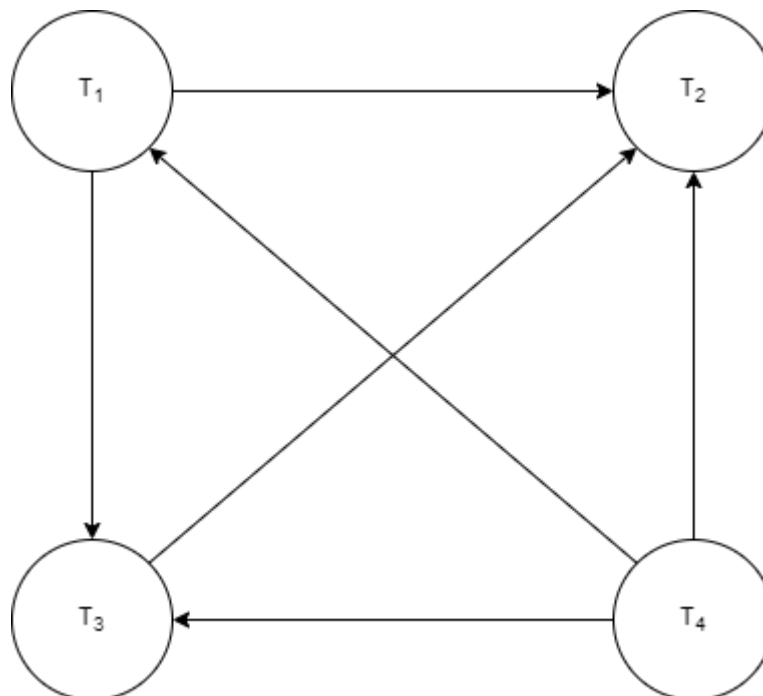
$$R_2 \leftarrow (Visitor \bowtie_{\sigma_{\{location = 'Hyde Park'\}}} (Park))$$

$$\pi_{\{vID\}}(R_1) - \pi_{\{vID\}}(R_1 \bowtie_{(R1.age < R2.age)} R_2)$$

Question 4

(a)

1.



2. Yes

Time	t ₁	t ₂	t ₃	t ₄	t ₅	t ₆	t ₇	t ₈	t ₉
T ₁			W(Y)	R(X)					
T ₂								R(Y)	W(Z)
T ₃					R(Z)	R(Y)	R(X)		
T ₄	W(Y)	W(X)							

(b)

1. Yes, there's a deadlock. T_3 wait for T_4 and T_4 wait for T_3 , there's a deadlock.

2.

Time	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8
T_1					WL(B)		RL(A)	
T_2				WL(A)		WL(C)		
T_3	WL(C)	RL(B)						
T_4			RL(B)					WL(C)

Question 5

(a) 3. Use a clustered B+ tree index on attribute R.b.

Because the cost of accessing the sorted file for R directly is high and hashed index can't support range searches.

(b)

1. Data pages: P1, P2, P3, P4

Q1: read P1, P2, P3

Q2: read P3, P2, P1, P4

Q3: read P3, P2, P4

Buffer:

P4	Q2	P2	Q2	P3	Q2
----	----	----	----	----	----

2. Data pages: P1, P2, P3, P4, P5

Q1: read P1, Q2: read P2, Q3: read P3, Q4: read P4, Q5: read P1, Q6: read

P3, Q7: read P5, Q8: read P3, Q9: read P1

Buffer:

P1	Q5	P2	P3	Q6	P4
----	----	----	----	----	----

In Q7, LRU release P4, FIFO release P1, MRU release P3, FIFO release P1, then read P3, so MRU is the worst. Read P1, so LRU is better than FIFO and it's the best.

Question 6

(a)

1. 49, because 49's binary number is 110001, it will be added in the last bucket, so split will occur.

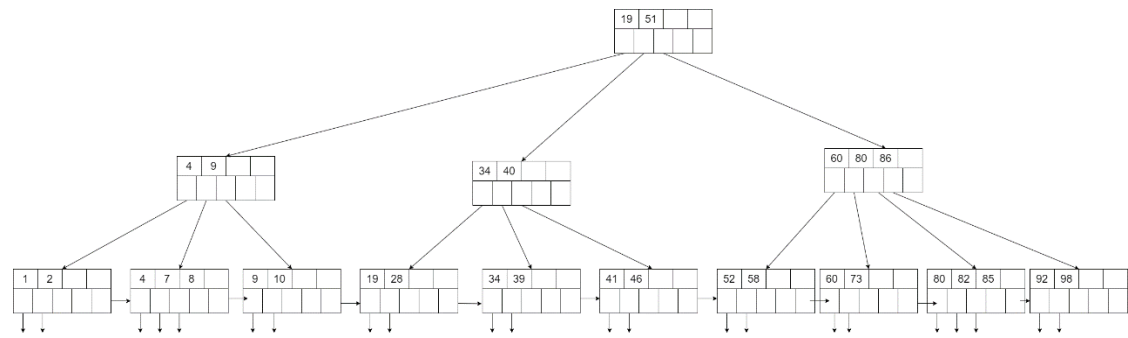
2.

		primary pages			
h1	h0				
000	00	8			
001	01	33	17	9	
010	10	34	22	78	
011	11	43	11	27	
100	00				
101	01	5	45		
110	10				
111	11	31	39		

(b)

1. 82 because $5 \times 5 \times 4 - 19 + 1$

2.



3.

