**Tashfeen Abbasi**

**I22-2041**

**DS-C/D**

**Q1**Consider the following relations:

● Systems(System\_ID, CPU\_ID, RAM1\_ID, RAM2\_ID, GPU\_ID, MotherBoard\_ID, PSU\_ID,

Storage\_ID)

● CPU(CPU\_ID, Name, Core\_Count, Clock\_Speed, Threads\_Per\_Core, Manufacturer, Price,

Power\_Draw)

● RAM(RAM\_ID, Size, Type, Clock\_Speed, Manufacturer, Price, Power\_Draw)

● GPU(GPU\_ID, Name, Clock\_Speed, Core\_Count, Manufacturer, Price, Power\_Draw)

● MotherBoard(MotherBoard\_ID, Name, RAM\_Slots, Manufacturer, Price, Power\_Draw)

**● PSU(PSU\_ID, Name, Manufacturer, Power Rating, Price)**

● Storage(Storage\_ID, Type, Size, Manufacturer, Price, Power\_Draw)

*Below are the relation algebra queries:*

**ID of all CPUs manufactured by Intel.**

1. *πCPU*\_*ID*​(*σManufacturer*=’*Intel’*​*(CPU*))

**ID of all Systems with empty RAM slots. (Empty Ram slots have id=0)**

1. *πSystem*\_*ID*​(*σRAM*1\_*ID*=0 *or RAM*2\_*ID*=0​(*Systems*))

**Price of all storage with Size over 500gb and Price less than 10,000.**

1. *πPrice*​(*σSize*>500 *and Price*<10000​(*Storage*))

**Power draw of all RAM of type ‘DDR4’ and size of 8 or more gb.**

1. *πPower*\_*Draw*​(*σType*=’*DDR*4’ *and Size*≥8​(*RAM*))

**Price of all PSUs with a power rating of 500W.**

1. *πPrice*​(*σPower*\_*Rating*=500​(*PSU*))

**ID of systems with CPUs of 4 or more total threads.**

1. *πSystem*\_*ID*​(*σThreads*\_*Per*\_*Core**\* Core*\_*Count* ≥ 4​(*Systems* ⋈ *CPU*))

**ID of systems with CPUs of 4 or more total threads.**

1. *πSystem*\_*ID*(*σRAM1\_ID.size+RAM2\_ID.size=16* ​(*Systems* ⋈ *RAM*))

**CPU name of all systems with Storage type = ‘SSD’.**

1. *πName*(*σType=’SSD’* ​(*Systems* ⋈ *Storage*)) ⋈ *CPU*)

**MotherBoardID of all Systems with a PSU of rating greater than 600W.**

1. *πMotherBoard*\_*ID*​*(σPower*\_*Rating*>600​(*Systems* ⋈ *PSU*))

**ID of all systems with the 2 Ram slots in the motherboard.**

1. *πSystem*\_*ID*​(*σRAM*\_*Slots*=2​(*Systems* ⋈ *MotherBoard*))

**ID of all systems with a processor and gpu that have the same core count and clock speed.**

1. *πSystem*\_*ID*​(*σCPU*.*Core*\_*Count*=*GPU*.*Core*\_*Count**and CPU*.*Clock*\_*Speed*=*GPU*.*Clock*\_*Speed CPU* ⋈ ​*Systems* ⋈*GPU*)

**ID of all systems which cost more than 500,000.**

1. *πSystem*\_*ID*(*σCPU.Price+RAM.Price+GPU.Price+MotherBoard.Price+PSU.Price+Storage.Price*>500000(*Systems* ⋈ *CPU* ⋈ *RAM* ⋈ *GPU* ⋈ *MotherBoard* ⋈ *PSU* ⋈ *Storage*))

**ID of all systems which have sufficient PSUs (Power rating is less than total power draw).**

1. *πSystem*\_*ID*(*σPSU*.*Power*\_*Rating*<(*CPU*.*Power*\_*Draw*+*RAM*.*Power*\_*Draw*+*GPU*.*Power*\_*Draw*+*MotherBoard*.*Power*\_*Draw*+*Storage*.*Power*\_*Draw*)(*Systems* ⋈ *CPU* ⋈ *RAM* ⋈ *GPU* ⋈ *MotherBoard* ⋈ *PSU* ⋈ *Storage*))

**ID of all systems which have the same GPU and CPU Manufacturers.**

1. *πSystem*\_*ID*​(*σ CPU*.*Manufacturer*=*GPU*.*Manufacturer*​( *CPU* ⋈ ​*Systems* ⋈*GPU*)

**Name of all Manufacturers who make every computer part.**

1. *πManufacturer*​(*CPU*) ∩ *πManufacturer*​(*RAM*) ∩ *πManufacturer*​(*GPU*) ∩ *πManufacturer*m (*MotherBoard*) ∩ *πManufacturer*​(*PSU*) ∩ *πManufacturer*​(*Storage*)

**Q2**

**Normalize this table into a database into 1NF, then 2NF and finally 3NF.**

**1NF**

Docter:

|  |  |  |  |
| --- | --- | --- | --- |
| **Doc no.** | **Name** | **Designation** | **Designation Salary** |
| D1 | Dr.Nadeem | Professor | 200000 |
| D2 | Dr.Nadeem | Professor | 200000 |
| D3 | Dr.Erum | Astt. Professor | 200000 |
| D4 | Dr.Hafeez | Astt. Professor | 120000 |

Phoneumber:

|  |  |  |  |
| --- | --- | --- | --- |
| **Doc no.** | **Phone** | **Department** | **Dept id** |
| D1 | 0333-123 | Neurology | Dep1 |
| D2 | 0334-124 | Orthopedic | Dep2 |
| D3 | 0321-123 | ENT | Dep3 |
| D3 | 042-123 | Neurology | Dep1 |
| D4 | 0321-124 | Skin | Dep4 |
| D4 | 0300-123 | Orthopedic | Dep2 |

Patient:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Doc no.** | **Patient no** | **Patient Name** | **CNIC** | **Phone** | **Room No** | **Room Type** | **Bed No** | **Room Charge(Daily)** | **Length of Stay(Days)** |
| D1 | P1 | Khalid | 12345-1 | 042-1 | R2 | Two Bed | B1 | 500 | 10 |
| D1 | P5 | Ahmed | 12345-2 | 042-2 | R2 | Two Bed | B1 | 500 | 20 |
| D1 | P7 | Anum | 12345-3 | 042-3 | R7 | One Bed | B1 | 1000 | 4 |
| D2 | P4 | Mehmood | 12345-4 | 042-4 | R2 | One Bed | B1 | 1000 | 12 |
| D2 | P7 | Anum | 12345-3 | 042-3 | R4 | Two Bed | B5 | 500 | 7 |
| D2 | P9 | Khawar | 12345-6 | 042-5 | R4 | Two Bed | B7 | 500 | 5 |
| D3 | P10 | Tanveer | 12345-7 | 042-6 | R7 | One Bed | B1 | 1000 | 18 |
| D3 | P1 | Khalid | 12345-1 | 042-1 | R5 | One Bed | B8 | 1000 | 22 |
| D4 | P12 | Sohail | 12345-9 | 042-8 | R8 | One Bed | B1 | 1000 | 9 |
| D4 | P13 | Kashif | 12346-0 | 042-9 | R6 | VIP | B9 | 5000 | 13 |

**2NF**

Doctor:

|  |  |  |  |
| --- | --- | --- | --- |
| **Doc no.** | **Name** | **Designation** | **Designation Salary** |
| D1 | Dr.Nadeem | Professor | 200000 |
| D2 | Dr.Nadeem | Professor | 200000 |
| D3 | Dr.Erum | Astt. Professor | 200000 |
| D4 | Dr.Hafeez | Astt. Professor | 120000 |

Phone:

|  |  |  |  |
| --- | --- | --- | --- |
| **Doc no.** | **Phone** | **Department** | **Dept id** |
| D1 | 0333-123 | Neurology | Dep1 |
| D2 | 0334-124 | Orthopedic | Dep2 |
| D3 | 0321-123 | ENT | Dep3 |
| D3 | 042-123 | Neurology | Dep1 |
| D4 | 0321-124 | Skin | Dep4 |
| D4 | 0300-123 | Orthopedic | Dep2 |

Patient:

|  |  |  |  |
| --- | --- | --- | --- |
| **Patient no** | **Patient Name** | **CNIC** | **Phone** |
| P1 | Khalid | 12345-1 | 042-1 |
| P5 | Ahmed | 12345-2 | 042-2 |
| P7 | Anum | 12345-3 | 042-3 |
| P4 | Mehmood | 12345-4 | 042-4 |
| P9 | Khawar | 12345-6 | 042-5 |
| P10 | Tanveer | 12345-7 | 042-6 |
| P12 | Sohail | 12345-9 | 042-8 |
| P13 | Kashif | 12346-0 | 042-9 |

Room:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Doc no.** | **Patient no** | **Room No** | **Room Type** | **Bed No** | **Room Charge(Daily)** | **Length of Stay(Days)** |
| D1 | P1 | R2 | Two Bed | B1 | 500 | 10 |
| D1 | P5 | R2 | Two Bed | B1 | 500 | 20 |
| D1 | P7 | R7 | One Bed | B1 | 1000 | 4 |
| D2 | P4 | R2 | One Bed | B1 | 1000 | 12 |
| D2 | P7 | R4 | Two Bed | B5 | 500 | 7 |
| D2 | P9 | R4 | Two Bed | B7 | 500 | 5 |
| D3 | P10 | R7 | One Bed | B1 | 1000 | 18 |
| D3 | P1 | R5 | One Bed | B8 | 1000 | 22 |
| D4 | P12 | R8 | One Bed | B1 | 1000 | 9 |
| D4 | P13 | R6 | VIP | B9 | 5000 | 13 |

**3NF**

Doctor:

|  |  |  |
| --- | --- | --- |
| **Doc no.** | **Name** | **Designation** |
| D1 | Dr.Nadeem | Professor |
| D2 | Dr.Nadeem | Professor |
| D3 | Dr.Erum | Astt. Professor |
| D4 | Dr.Hafeez | Astt. Professor |

Salary:

|  |  |
| --- | --- |
| **Designation** | **Designation Salary** |
| Professor | 200000 |
| Professor | 200000 |
| Astt. Professor | 200000 |
| Astt. Professor | 120000 |

Phone:

|  |  |
| --- | --- |
| **Doc no.** | **Phone** |
| D1 | 0333-123 |
| D2 | 0334-124 |
| D3 | 0321-123 |
| D3 | 042-123 |
| D4 | 0321-124 |
| D4 | 0300-123 |

Department:

|  |  |  |
| --- | --- | --- |
| **Doc no.** | **Department** | **Dept id** |
| D1 | Neurology | Dep1 |
| D2 | Orthopedic | Dep2 |
| D3 | ENT | Dep3 |
| D3 | Neurology | Dep1 |
| D4 | Skin | Dep4 |
| D4 | Orthopedic | Dep2 |

Patient:

|  |  |  |  |
| --- | --- | --- | --- |
| **Patient no** | **Patient Name** | **CNIC** | **Phone** |
| P1 | Khalid | 12345-1 | 042-1 |
| P5 | Ahmed | 12345-2 | 042-2 |
| P7 | Anum | 12345-3 | 042-3 |
| P4 | Mehmood | 12345-4 | 042-4 |
| P9 | Khawar | 12345-6 | 042-5 |
| P10 | Tanveer | 12345-7 | 042-6 |
| P12 | Sohail | 12345-9 | 042-8 |
| P13 | Kashif | 12346-0 | 042-9 |

Room:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Patient no** | **Room No** | **Room Type** | **Bed No** | **Room Charge(Daily)** | **Length of Stay(Days)** |
| P1 | R2 | Two Bed | B1 | 500 | 10 |
| P5 | R2 | Two Bed | B1 | 500 | 20 |
| P7 | R7 | One Bed | B1 | 1000 | 4 |
| P4 | R2 | One Bed | B1 | 1000 | 12 |
| P7 | R4 | Two Bed | B5 | 500 | 7 |
| P9 | R4 | Two Bed | B7 | 500 | 5 |
| P10 | R7 | One Bed | B1 | 1000 | 18 |
| P1 | R5 | One Bed | B8 | 1000 | 22 |
| P12 | R8 | One Bed | B1 | 1000 | 9 |
| P13 | R6 | VIP | B9 | 5000 | 13 |

Doctor\_patient:

|  |  |
| --- | --- |
| **Doc no.** | **Patient no** |
| D1 | P1 |
| D1 | P5 |
| D1 | P7 |
| D2 | P4 |
| D2 | P7 |
| D2 | P9 |
| D3 | P10 |
| D3 | P1 |
| D4 | P12 |
| D4 | P13 |

Doctor\_Room:

|  |  |
| --- | --- |
| **Room No** | **Doc no** |
| R2 | D1 |
| R7 | D1 |
| R4 | D2 |
| R5 | D3 |
| R8 | D4 |
| R6 | D4 |

**Explain why it is not preferable to always convert tables into 4NF and 5NF.**

Converting tables into Fourth Normal Form (4NF) and Fifth Normal Form (5NF) is not always preferable due to several reasons:

* **Increased Complexity:** Achieving higher normal forms often requires decomposing tables into smaller ones, which can lead to an increase in the number of tables and joins needed for queries. This can make the database schema more complex and harder to understand.
* **Performance Impact:** With more tables and joins, query performance can suffer. Join operations can be resource-intensive, especially on large datasets. Therefore, overly normalized schemas can result in slower query execution times.
* **Data Integrity Maintenance:** Maintaining data integrity becomes more complex in highly normalized schemas. Updates, inserts, and deletes may require modifying multiple tables, increasing the risk of inconsistencies if not handled properly.
* **Denormalization Benefits:** Sometimes, denormalized schemas (i.e., schemas with redundant data) are preferred for performance reasons. Denormalization can reduce the need for joins and improve query performance, especially for read-heavy workloads.
* **Storage Overhead:** Normalization can lead to increased storage overhead due to the need for additional tables and indexes. While storage is relatively inexpensive, it can still be a consideration, especially for large-scale systems.