

1. Fill the following table using relational algebra operations. [6 Marks]

Operator Symbol	Operator Name	Operator Symbol	Operator Name
Π	Projection	\cap	intersect
σ	Selection	\bowtie	Join
ρ	Rename	\leftarrow	Assignment
\cup	Union	\wedge	AND
\times	Cross Product	\vee	OR
$-$	Minus	\neg	NOT

2. Consider the relations: Suppliers(SID, Sname, Rating), Parts(PID, Pname, Color)**Catalog(SID, PID, Cost)**

Query 1: Retrieve SIDs of Suppliers whose rating > 10. [2 Marks]

$$\pi_{SID} (\sigma_{\text{rating} > 10} (\text{Suppliers}))$$

Query 2: Retrieve SIDs of Suppliers who supplied red parts. [2 Marks]

$$\begin{aligned}
 1. & \pi_{SID} (\sigma_{\text{Color} = \text{RED}} (\text{Catalog} \bowtie \text{Parts})) \Rightarrow \text{More Cost} \\
 \text{or} \\
 2. & \pi_{SID} (\sigma_{\substack{C.PID = P.PID \\ \wedge P.Color = \text{RED}}} (\text{Catalog} \times \text{Parts})) \Rightarrow \text{Less Cost} \\
 \text{or [optimization criteria]} \\
 3. & \pi_{SID} [\pi_{PID} (\sigma_{\text{Color} = \text{RED}} (\text{Parts}) \bowtie \text{Catalog})] \Rightarrow \text{Less Cost}
 \end{aligned}$$

Query 3: Retrieve Sname of Suppliers who supplied red parts. [2 Marks]

$$\begin{aligned}
 1. & \pi_{Sname} [\sigma_{\text{Color} = \text{RED}} (\text{Catalog} \bowtie \text{Parts} \bowtie \text{Suppliers})] \\
 2. & \pi_{Sname} [\pi_{SID} ((\sigma_{\text{Color} = \text{RED}} (\text{Parts}) \bowtie \text{Catalog}) \bowtie \text{Suppliers})] \Rightarrow \text{more efficient} \\
 3. & \pi_{Sname} [\pi_{SID} [\pi_{PID} (\sigma_{\text{Color} = \text{RED}} (\text{Parts}) \bowtie (\pi_{SID, PID} (\text{Catalog}))] \bowtie [\pi_{SID, Sname} (\text{Suppliers})]]] \\
 & \quad \quad \quad \downarrow \\
 & \quad \quad \text{more efficient}
 \end{aligned}$$

Query 4: Retrieve SIDs of Suppliers to supply some red part or some green part. [2 Marks]

$$1. \pi_{SID} \left[\left[\begin{array}{l} \sigma_{\text{Color} = 'RED'}(\text{parts}) \\ \vee \\ \sigma_{\text{Color} = 'Green'}(\text{parts}) \end{array} \right] \bowtie \text{Catalog} \right]$$

$$2. \pi_{SID} \left[\pi_{PID} \left[\left[\begin{array}{l} \sigma_{\text{Color} = 'RED'}(\text{parts}) \\ \vee \\ \sigma_{\text{Color} = 'Green'}(\text{parts}) \end{array} \right] \bowtie \left[\pi_{PID, SID}(\text{Catalog}) \right] \right] \right]$$

Query 5: Retrieve SIDs of Suppliers who don't supply any part. [2 Marks]

SID_S : Who don't supply any part.

$$\pi_{SID}(\text{Suppliers}) - \pi_{SID}(\text{Catalog})$$

3. Given two relations R1 and R2, where R1 contains N1 tuples and R2 contains N2 tuples, and $N2 > N1 > 0$, give the maximum and minimum possible sizes (in tuples) for the result relation produced by each of the following relational algebra expressions. In each case, state any assumptions about the schemas for R1 and R2 that are needed to make the expression meaningful. (a) $R1 \cup R2$ (b) $R1 \cap R2$ (c) $R1 - R2$ (d) $R1 \times R2$ [4Marks]

Operator Name	Minimum Value	Maximum Value
$R1 \cup R2$ Assumption: R1 and R2 are union compatible	Min: N2	Max: N1 + N2
$R1 \cap R2$ Assumption: R1 and R2 are union compatible	Min: 0	Max: N1
$R1 - R2$ Assumption: R1 and R2 are union compatible	Min: 0	Max: N1
$R1 \times R2$	Min: N1 * N2	Max: N1 * N2