Problem 1

Consider four different transaction execution histories (include read/write opearations)

\[ H_1 = \text{r}_1[\text{x}]\text{r}_1[\text{y}]\text{w}_1[\text{y}]\text{r}_2[\text{y}]\text{w}_2[\text{y}]\text{r}_2[\text{x}]\text{w}_2[\text{x}]\text{r}_2[\text{z}] \]
\[ H_2 = \text{r}_2[\text{y}]\text{r}_2[\text{x}]\text{w}_2[\text{y}]\text{r}_2[\text{z}]\text{r}_1[\text{x}]\text{r}_1[\text{y}]\text{w}_1[\text{y}] \]
\[ H_3 = \text{r}_2[\text{y}]\text{w}_2[\text{x}]\text{r}_1[\text{x}]\text{r}_1[\text{z}]\text{w}_1[\text{z}]\text{w}_3[\text{z}]\text{r}_1[\text{y}]\text{r}_2[\text{y}] \]
\[ H_4 = \text{w}_2[\text{x}]\text{w}_3[\text{z}]\text{r}_3[\text{x}]\text{r}_4[\text{y}]\text{r}_3[\text{z}]\text{w}_1[\text{y}]\text{w}_4[\text{x}]\text{r}_1[\text{x}]\text{r}_1[\text{z}]\text{r}_4[\text{z}] \]

Answer the following questions:

1. List all the conflicting pairs for \( H_1 \) and \( H_2 \).
2. Are \( H_1 \) and \( H_2 \) conflict equivalent and why?
3. For \( H_3 \) and \( H_4 \),
   - Give the serialization graph.
   - Determine whether or not the schedule is serializable, and justify your answer.
   - If the schedule is serializable, specify a serial order of transaction execution to which it is equivalent.

Problem 2

Suppose user Bob has privileges to read a secret table \( T \). User Mallory wants to see the data in \( T \) (but does not have the privileges to do so). If the system is using Discretionary AC (Access Control), Mallory may have the chance to conduct a Trojan Horse Attack by performing the following steps:
1. *Mallory* creates a table $T'$ and gives INSERT privileges to *Bob*.

2. *Mallory* tricks *Bob* into copying data from $T$ to $T'$ (e.g. by extending the "functionality" of a program used by *Bob*).

3. *Mallory* can then see the data that comes from $T$

**Mandatory AC** could stop this kind of attack. For example, if we are using the *Bell-LaPadula Model*, where four different *Security Clearances* are provided: Top Secret($TS$), Secret($S$), Confidential($C$), unclassified($U$). Order of the privilege level is

$$TS > S > C > U$$

(1)

Suppose user *Bob* still has privileges to read a secret table $T$, which means

$$\text{clearance}(Bob) := S$$

(2)

And User *Mallory* still wants to see the data in $T$ (but does not have the privileges to do so).

$$\text{clearance}(Mallory) < S$$

(3)

**Explain**: why user *Mallory* can not see the content of secret table $T$, if he tries to use the same strategy as described above, under *Bell-LaPadula Model*.

**Problem 3**

Consider the following relational schema:

- **EMPLOYEE**($Fname$, $Lname$, $Ssn$, $Bdate$, $Address$, $Salary$, $Dno$)
- **PROJECT**($Pname$, $Pnumber$, $Plocation$, $Dnum$)
- **WORKS_ON**($Essn$, $Pno$, $Hours$)

where **WORKS_ON**.$Essn$ is a foreign key to **EMPLOYEE**.$Ssn$, and **WORKS_ON**.$Pno$ is a foreign key to **PROJECT**.$Pnumber$.

Consider the following SQL query:

```sql
SELECT $Pnumber$, $Pname$, COUNT(*)
FROM **PROJECT**, **WORKS_ON**, **EMPLOYEE**
WHERE $Pnumber$ = $Pno$ AND $Ssn$=Essn AND $Dno$ = 5
GROUP BY $Pnumber$, $Pname`
```

Draw two query trees that can represent this query. Argue why these are equivalent (i.e., which rules you applied to get one from the other).
Problem 4

Let $V$ be a view created over relation $R$ (create view $V$ as $SELECT \ldots FROM \ldots$). Assume that initially $Bob$ has all permissions on $R$ (including permission to grant permissions to others), nobody else has permissions on $R$, and that $Alice$ and $Clara$ have select permission on $V$.

Now consider the sequence of commands executed by the specified users to grant and revoke permissions as showed in Table 1:

<table>
<thead>
<tr>
<th>Order</th>
<th>Command</th>
<th>Executed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grant Select on $R$ To Alice with Grant Option</td>
<td>Bob</td>
</tr>
<tr>
<td>2</td>
<td>Grant Select on $R$ To Clara</td>
<td>Alice</td>
</tr>
<tr>
<td>3</td>
<td>Grant Select on $R$ To Donald</td>
<td>Alice</td>
</tr>
<tr>
<td>4</td>
<td>Grant Select on $R$ To Clara</td>
<td>Bob</td>
</tr>
<tr>
<td>5</td>
<td>Revoke Select on $R$ From Alice</td>
<td>Bob</td>
</tr>
</tbody>
</table>

*Table 1*

**Question:** Which of $Bob$, $Alice$, $Clara$, $Donald$ are authorized to execute each of the commands as showed in Table 2 at the conclusion of this sequence.

<table>
<thead>
<tr>
<th>Command</th>
<th>Bob</th>
<th>Alice</th>
<th>Clara</th>
<th>Donald</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELECT $X$ FROM $R$ WHERE $Y &lt; 100$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UPDATE $R$ SET $Y = Y \ast 3$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SELECT $A$ FROM $V$ WHERE $C = 10$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CREATE VIEW $View2$ AS SELECT $*$ FROM $R$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 2*