**Lab 10 Relations**

**Objective**

Solving exercises from the text book.

**Current Lab Learning Outcomes (LLO)**

By completion of the lab, the students should be able to

1. Understand Relations and representation of relation.

2. Understand the properties of a relation

3. Solve shorter/easier or longer / harder problems given in the textbook.

**Lab Requirements**

Students allowed using their lecture notes in the lab and use blackboard slides in order to solve the exercises.

**Lab Assessment**

1- Divide students to groups and let them to solve the given example.

2- Discuss the answers with the groups and write on board the optimal solution

1. List the ordered pairs in the relation *R* from *A* = {0*,* 1*,* 2*,* 3*,* 4} to *B* = {0*,* 1*,* 2*,* 3}, where *(a, b)* ∈ *R* if and only if

**a)** *a* = *b*. **b)** *a* + *b* = 4. **c)** *a > b*. **d)** *a* | *b*. **e)** gcd*(a, b)* = 1. **f )** lcm*(a, b)* = 2.

1. Represent the relation R={(1,1),(1,2),(1,3),(1,4),(2,2),(2,3),(2,4),(3,3) (3,4),(4,4)} as Arrow diagram, digraph, table and as a 0-1 matrix.
2. For each of these relations on the set {1*,* 2*,* 3*,* 4}, determine whether it is reflexive, whether it is symmetric, whether it is antisymmetric, and whether it is transitive.

**a)** {*(*2*,* 2*), (*2*,* 3*), (*2*,* 4*), (*3*,* 2*), (*3*,* 3*), (*3*,* 4*)*}

**b)** {*(*1*,* 1*), (*1*,* 2*), (*2*,* 1*), (*2*,* 2*), (*3*,* 3*), (*4*,* 4*)*}

**c)** {*(*2*,* 4*), (*4*,* 2*)*}

**d)** {*(*1*,* 2*), (*2*,* 3*), (*3*,* 4*)*}

**e)** {*(*1*,* 1*), (*2*,* 2*), (*3*,* 3*), (*4*,* 4*)*}

1. Give an example of an irreflexive relation on the set of all people.
2. Let *R*1 = {*(*1*,* 2*), (*2*,* 3*), (*3*,* 4*)*} and *R*2 = {*(*1*,* 1*), (*1*,* 2*)*, *(*2*,* 1*)*, *(*2*,* 2*)*, *(*2*,* 3*)*, *(*3*,* 1*)*, *(*3*,* 2*)*, *(*3*,* 3*)*, *(*3*,* 4*)*} be relationsfrom {1*,* 2*,* 3} to {1*,* 2*,* 3*,* 4}. Find

**a)** *R*1 ∪ *R*2. **b)** *R*1 ∩ *R*2. **c)** *R*1 − *R*2. **d)** *R*2 − *R*1.

1. Determine whether the relation *R* on the set of all real numbers is reflexive, symmetric, antisymmetric, and/or transitive, where *(x, y)* ∈ *R* if and only if

**a)** *x* + *y* = 0. **b)** *x* = ±*y*. **c)** *x* − *y* is a rational number.

1. Let *R* be the relation on the set {0*,* 1*,* 2*,* 3} containing the ordered pairs *(*0*,* 1*)*, *(*1*,* 1*)*, *(*1*,* 2*)*, *(*2*,* 0*)*, *(*2*,* 2*)*, and *(*3*,* 0*)*. Find the
   1. reflexive closure of *R*. **b)** symmetric closure of *R*.
2. Which of these relations on {0*,* 1*,* 2*,* 3} are equivalence relations? Determine the properties of an equivalence relation that the others lack.

**a)**{*(*0*,* 0*), (*1*,* 1*), (*1*,* 3*), (*2*,* 2*), (*2*,* 3*), (*3*,* 1*), (*3*,* 2*),(*3*,* 3*)*} **b)** {*(*0*,* 0*), (*0*,* 1*), (*0*,* 2*), (*1*,* 0*), (*1*,* 1*), (*1*,* 2*), (*2*,* 0*),(*2*,* 2*), (*3*,* 3*)*}

1. What is the composite of the relations *R* and *S*, where *R* is the relation from {1*,* 2*,* 3} to {1*,* 2*,* 3*,* 4} with *R* = {*(*1*,* 1*), (*1*,* 4*), (*2*,* 3*), (*3*,* 1*), (*3*,* 4*)*} and *S* is the relation from {1*,* 2*,* 3*,* 4} to {0*,* 1*,* 2} with *S* = {*(*1*,* 0*), (*2*,* 0*), (*3*,* 1*), (*3*,* 2*), (*4*,* 1*)*}?
2. Let *R* be the relation on the set {1*,* 2*,* 3*,* 4*,* 5} containing the ordered pairs *(*1*,* 1*)*, *(*1*,* 2*)*, *(*1*,* 3*)*, *(*2*,* 3*)*, *(*2*,* 4*)*, *(*3*,* 1*)*,*(*3*,* 4*)*, *(*3*,* 5*)*, *(*4*,* 2*)*, *(*4*,* 5*)*, *(*5*,* 1*)*, *(*5*,* 2*)*, and *(*5*,* 4*)*. Find

**a)** *R*2. **b)** *R*3.

1. Find the transitive closures of these relations on {1*,* 2*,* 3*,* 4}.

**a)** {*(*1*,* 2*), (*2*,*1*), (*2*,*3*), (*3*,*4*), (*4*,*1*)*} **b)** {*(*2*,* 1*), (*2*,*3*), (*3*,*1*), (*3*,*4*), (*4*,*1*), (*4*,* 3*)*} **c)** {*(*1*,* 2*), (*1*,*3*), (*1*,*4*), (*2*,*3*), (*2*,*4*), (*3*,* 4*)*} **d)** {*(*1*,* 1*), (*1*,*4*), (*2*,*1*), (*2*,*3*), (*3*,*1*), (*3*,* 2*), (*3*,*4*), (*4*,* 2*)*}