**Algorithm and Data Structure Practicum**

**Jobsheet 2 : Algorithm and Data Structure Practicum**



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Consider these relations on the set of integers  
R1 = {(a, b)|a ≤ b}  
R2 = {(a, b)|a > b}  
R3 = {(a, b)| a = b or a = -b}  
R4 = {(a, b)| a = b}  
R5 = {(a, b)| a = b + 1}  
R6 = {(a, b)| a + b ≤ 3}  
Determine whether each of these relations are equivalence

Answer:

R1 =

Reflexivity: (a, a) ∈ R for all a ∈ A.

Symmetry: If (a, b) ∈ R, then (b, a) ∈ R for all a, b ∈ A.

Transitivity: If (a, b) ∈ R and (b, c) ∈ R, then (a, c) ∈ R for all a, b, c ∈ A.

R1 satisfies reflexivity and transitivity, but it fails to satisfy symmetry. Specifically, if a ≤ b, it does not necessarily follow that b ≤ a. Thus, the relation is not symmetric, and hence, it is not an equivalence relation.

**Therefore, R1 is not an equivalence relation.**

R2

Reflexivity: (a, a) ∉ R2 for all a ∈ SET OF INTEGERS, because a > a is false.

Symmetry: (a, b) ∈ R2 if and only if a > b. But if a > b, then b < a, so (b, a) ∉ R2. Thus, R2 is not symmetric.

Transitivity: If (a, b) ∈ R2 and (b, c) ∈ R2, then a > b and b > c, so a > c, and (a, c) ∈ R2. Thus, R2 is transitive.

**Therefore, R2 is not an equivalence relation.**

R3

Reflexivity: (a, a) ∈ R3 for all a ∈ SET OF INTEGERS, because a = a or a = -a.

Symmetry: (a, b) ∈ R3 if and only if a = b or a = -b. But if a = b, then b = a, so (b, a) ∈ R3. If a = -b, then -b = a, so (-b, a) ∈ R3. Thus, R3 is symmetric.

Transitivity: If (a, b) ∈ R3 and (b, c) ∈ R3, then either a = b or a = -b, and either b = c or b = -c.

* If a = b and b = c, then a = c, so (a, c) ∈ R3.
* If a = b and b = -c, then a = -c, so (a, c) ∈ R3 and (c, a) ∈ R3, thus R3 is transitive.
* If a = -b and -b = c, then a = -c, so (a, c) ∈ R3 and (c, a) ∈ R3, thus R3 is transitive.
* If a = -b and b = -c, then a = c, so (a, c) ∈ R3.

**Thus, R3 is an equivalence relation.**

R4

Reflexivity: (a, a) ∈ R4 for all a ∈ SET OF INTEGERS, because a = a.

Symmetry: (a, b) ∈ R4 if and only if a = b. But if a = b, then b = a, so (b, a) ∈ R4. Thus, R4 is symmetric.

Transitivity: If (a, b) ∈ R4 and (b, c) ∈ R4, then a = b and b = c, so a = c, and (a, c) ∈ R4. Thus, R4 is transitive

**Thus, R4 is an equivalence relation.**

R5

Reflexivity: (a, a-1) ∉ R5 for all a ∈ SET OF INTEGERS, because a ≠ a + 1.

Symmetry: (a, b) ∈ R5 if and only if a = b + 1. But if a = b + 1, then b = a - 1, so (b, a) ∈ R5. Thus, R5 is symmetric.

Transitivity: If (a, b) ∈ R5 and (b, c) ∈ R5, then a = b + 1 and b = c + 1, so a = c + 2, and (a, c) ∉ R5. Thus, R5 is not transitive.

**Therefore, R5 is not an equivalence relation.**

R5

Reflexivity: (a, a) ∈ R6 for all a ∈ SET OF INTEGERS, because a + a = 2a ≤ 3.

Symmetry: (a, b) ∈ R6 if and only if a + b ≤ 3. But if a + b ≤ 3, then b + a ≤ 3, so (b, a) ∈ R6. Thus, R6 is symmetric.

Transitivity: If (a, b) ∈ R6 and (b, c) ∈ R6, then a + b ≤ 3 and b + c ≤ 3, so a + b + b + c ≤ 6, which implies a + c + 2b ≤ 6. Since b is an integer, 2b ≤ 2, so a + c + 2b ≤ a + c + 2, which means a + c ≤ 4. Therefore, (a, c) ∈ R6. Thus, R6 is transitive.

**Therefore, R6 is an equivalence relation.**