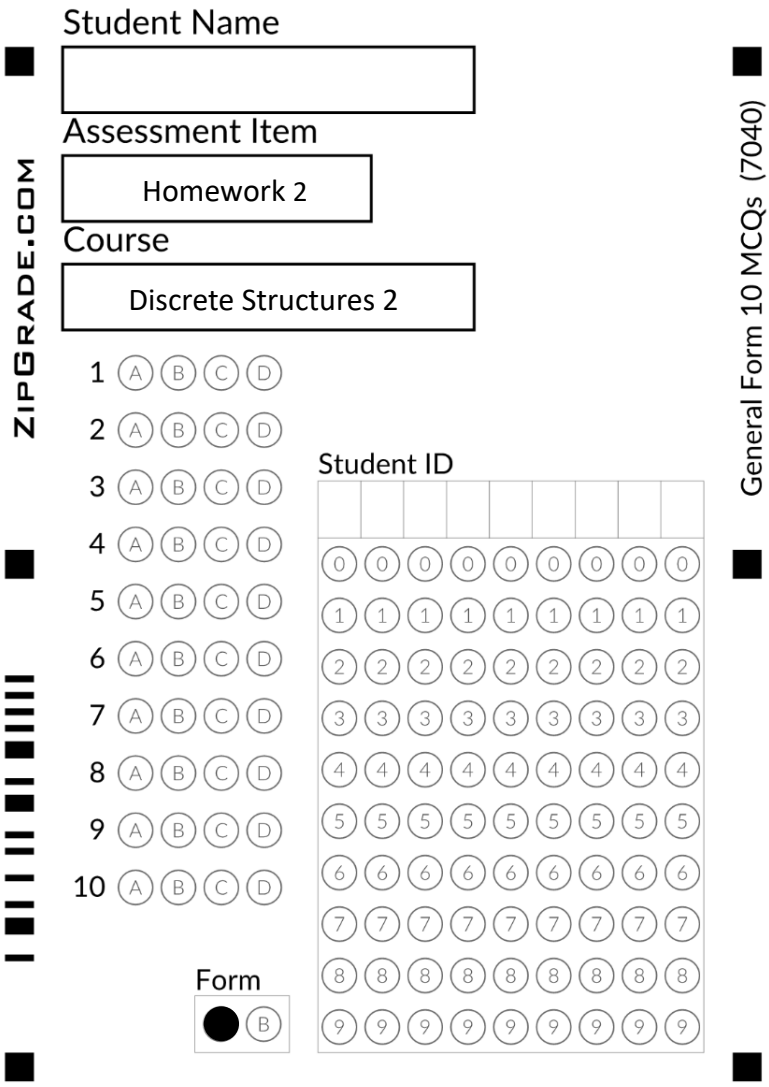

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ASSIGNMENT 2: RELATIONS

CS1303 Discrete Structures 2

Second Semester
1447 - 2026

MAY 3, 2026

Department of Computer Science and Artificial Intelligence
College of Computing
Umm Al-Qura University

Problem Set 2

(10 marks)

Based on your understanding of the topics discussed in Lectures 6 and 7, answer the following questions.

Q1) Let the set be $\{a, b, c, d\}$. A relation R is defined on this set as follows:

$$R = \{(a,a),(a,c),(a,d),(b,a),(b,b),(b,c),(b,d),(c,b),(c,c),(d,b),(d,d)\}$$

Decide whether the relation R is reflexive, symmetric or antisymmetric. For each part, say "Yes" or "No" and briefly explain your answer.

A) Reflexive: Yes, Symmetric: Yes, Antisymmetric: No

B) Reflexive: Yes, Symmetric: No, Antisymmetric: No

C) Reflexive: No, Symmetric: No, Antisymmetric: Yes

D) Reflexive: Yes, Symmetric: No, Antisymmetric: Yes

Q1 Hand-Calculated Solution:

Q2) Let the set be $S = \{a, b, c, d\}$. A relation R is defined on S as follows:

$$R = \{ (a,a), (a,c), (a,d), (b,a), (b,b), (b,c), (b,d), (c,b), (c,c), (d,b), (d,d) \}$$

Is the relation R transitive? Briefly explain your answer.

A) Yes, because it satisfies the condition.

B) Yes, because every element maps to itself.

C) No, because (a, c) and (c, b) are in R, but (a, b) is not in R.

D) No, because the relation does not contain (c, a) to complete the loop for (a, c).

Q2 Hand-Calculated Solution:

Q3) You are given the following relation that describes properties of the planets in our solar system:

R = { (Mercury, 0.39, 0), (Venus, 0.723, 0), (Earth, 1, 1), (Mars, 1.524, 2), (Jupiter, 5.203, 67), (Saturn, 9.539, 62), (Uranus, 19.19, 27), (Neptune, 30.06, 13) }

Considering the attributes of this relation (Name, Mean Distance from Sun in AU, Number of Moons), which attribute(s) can serve as a primary key for the relation? In other words, which attribute(s) uniquely identify each row (planet) in the table? And why?

A) Only "Name".

B) Only "Number of Moons".

C) Either "Name" or "Mean Distance from Sun in AU".

D) No single attribute can serve as a primary key.

Q3 Hand-Calculated Solution:

Q4) Let R be a relation on the set of real numbers $\mathbb{R}$ defined as follows:

For real numbers a and b, we say aRb if and only if $\lfloor a \rfloor = \lfloor b \rfloor$, where $\lfloor x \rfloor$ denotes the floor of x. In other words, $R = \{(a, b) \in \mathbb{R} \times \mathbb{R} \mid \lfloor a \rfloor = \lfloor b \rfloor\}$

Determine whether the relation R is reflexive, symmetric or antisymmetric. For each part, say "Yes" or "No" and briefly explain your answer.

A) Reflexive and Symmetric only

B) Reflexive and Antisymmetric only

C) Symmetric and Antisymmetric only

D) Reflexive, Symmetric, and Antisymmetric

Q4 Hand-Calculated Solution:

Q5) For the same relation as in **Q4**, determine whether R is also transitive or not. You must justify your answer using a concrete example.

A) Yes, because if ⌊a⌋ = ⌊b⌋ and ⌊b⌋ = ⌊c⌋, it logically follows that ⌊a⌋ = ⌊c⌋.

B) Yes, but only for integer values where a = b = c.

C) No, because ⌊1.5⌋ = ⌊1.9⌋ but 1.5 ≠ 1.9.

D) No, because floor functions do not preserve the transitive property for negative numbers.

Q5 Hand-Calculated Solution:

Q6) For the same relation as in **Q4**, determine whether R is an equivalence relation or not. You must justify your answer with some concrete examples.

A) Yes, because it is reflexive, symmetric, and transitive.

B) No, because while it is reflexive and symmetric, it lacks transitivity.

C) No, because it is not antisymmetric, which is a requirement for an equivalence relation.

D) Yes, because all relations defined strictly on real numbers are equivalence relations.

Q6 Hand-Calculated Solution:

Q7) Let $A = \{1, 2, 3, 4\}$ and $B = \{a, b, c\}$. Two relations from A to B are given by:
$R = \{(1, a), (1, b), (2, b), (3, c), (4, a)\}$
$S = \{(1, b), (2, a), (2, c), (3, c), (4, b)\}$
Which of the following explicitly represents the relation $S - R$ as a set of ordered pairs?

A) $\{(1, a), (2, b), (4, a)\}$

B) $\{(2, a), (2, c), (4, b)\}$

C) $\{(1, b), (3, c)\}$

D) $\{(1, a), (2, a), (2, b), (2, c), (4, a), (4, b)\}$

Q7 Hand-Calculated Solution:

Q8) Let $A = \{1, 2, 3\}$, $B = \{x, y\}$, $C = \{\alpha, \beta\}$. Two relations are given:
$R \subseteq A \times B = \{(1, x), (2, x), (2, y), (3, y)\}$ and $S \subseteq B \times C = \{(x, \alpha), (x, \beta), (y, \beta)\}$
Compute the composite $S \circ R$ as a set of ordered pairs.

A) $\{(x, 1), (x, 2), (\alpha, x), (\beta, y)\}$

B) $\{(1, \alpha), (1, \beta), (2, \alpha), (2, \beta), (3, \beta)\}$

C) $\{(1, x, \alpha), (2, x, \beta), (2, y, \beta)\}$

D) $\{(\alpha, 1), (\beta, 1), (\alpha, 2), (\beta, 2), (\beta, 3)\}$

Q8 Hand-Calculated Solution:

Q9) Let $R = \{(1,1), (2,2), (3,3), (4,4), (5,5), (6,6), (4,5), (5,4), (4,6), (6,4), (5,6), (6,5)\}$ be an equivalence relation from $\{1, 2, 3, 4, 5, 6\}$. Find $[1]$, $[2]$, $[3]$, $[4]$, $[5]$ and $[6]$.

A) $[1] = \{1\}, [2] = \{2\}, [3] = \{3\}, [4] = \{4,5\}, [5] = \{5,6\}, [6] = \{4,6\}$

B) $[1] = [2] = [3] = \{1,2,3\}\ and\ [4] = [5] = [6] = \{4,5,6\}$

C) $[1] = \{1\}, [2] = \{2\}, [3] = \{3\}, and\ [4] = [5] = [6] = \{4,5,6\}$

D) All elements belong to a single equivalence class: $\{1, 2, 3, 4, 5, 6\}$

Q9 Hand-Calculated Solution:

Q10) Does the equivalence classes of the relation R in **Q9** form a partition of $\{1, 2, 3, 4, 5, 6\}$? Justify your answer and write this partition.

A) Yes, because the equivalence classes are mutually disjoint and their union equals the original set {1, 2, 3, 4, 5, 6}.

B) Yes, because some equivalence classes overlap, ensuring all elements are fully covered.

C) No, because elements 1, 2, and 3 do not relate to 4, 5, and 6, leaving the set mathematically disconnected.

D) No, because a partition requires all subsets to have an equal number of elements.

Q10 Hand-Calculated Solution: