UNIVERSITY COMPUTER SCIENCE • EXERCISE SHEET

2.2 Sets, functions and relations

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

KEY WORDS power set • injective • equivalence relation

Objective

Compute with sets; classify functions; test relations.

1 Key knowledge and worked examples

■ The toolkit

Union, intersection, difference, complement; $|\mathcal{P}(A)| = 2^{|A|}$ – subsets pair with bit strings ✓. Injective (distinct inputs, distinct outputs), surjective (every output hit), bijective (both); $g \circ f$ applies f first.

■ Worked example: relation testing

On $\{1, 2, 3\}$: $R = \{(1, 1), (2, 2), (3, 3), (1, 2), (2, 1)\}$ – reflexive (all loops present), symmetric (pairs come in twos), transitive ($(1, 2), (2, 1)$ demand $(1, 1)$ – present) ✓.

2 Practice

2.1 How many subsets does a 4-element set have? [3]

2.2 Is $f(n) = n + 1$ on the integers injective, surjective, both? [3]

2.3 What does a symmetric relation's matrix look like? [3]

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3 Exam-style questions

3.1 $A = \{1, 2, 3, 4\}$, $B = \{2, 4, 6\}$.

Compute $|A \cup B|$, $|A \cap B|$, $|A - B|$, $|B - A|$ ✓ and verify $|A \cup B| = |A| + |B| - |A \cap B|$ numerically ✓. Then count the functions from A to B ($3^4 = 81$) and the injections from B to A ($4 \times 3 \times 2 = 24$), naming the rule used each time ✓. [8]

3.2 Three relations on $\{a, b, c\}$, given as sets of pairs.

$R_1 = \{(a, a), (b, b), (c, c)\}$: reflexive, symmetric, antisymmetric, transitive ✓. $R_2 = \{(a, b), (b, a)\}$: symmetric not reflexive; is it transitive? – no: $(a, b), (b, a)$ demand (a, a), absent ✓. R_3 with $(a, b), (b, c)$ only: transitive requires (a, c) – test what is missing ✓. State which of the three is an equivalence relation (only R_1) and why ✓. [7]

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