Short test questions

Discrete Mathematics 1.

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1 Sets

1.1. Define the *axiom of extensionality*.
1.2. Define *subset* and *proper subset*, and write their notation.
1.3. Define the *empty set*, and write its notation.
1.4. Define the *union* of two sets, and write its notation.
1.5. Define the *union of a system of sets*, and write its notation.
1.6. Write down the *commutativity*, *associativity* and *idempotence* rule of set union.
1.7. Define the *intersection* of two sets and a systems of sets, and write their notation.
1.8. Define *disjoincy* and *pairwise disjoincy*.
1.9. Write down the *commutativity*, *associativity* and *idempotence* rule of set intersection.
1.10. Write down the *distributivity* rules of union and intersection.
1.11. Define the *difference*, *symmetric difference* and *complement* of sets.
1.12. Write down the *de Morgan's laws* of two sets.
1.13. Define the *power set*, and write its notation.

2 Relations

2.1. Define the *ordered pair* and its *coordinates*.
2.2. Define the *Cartesian product* of two sets.
2.3. Define *binary relations* and write the notation.
2.4. Define the *domain* and the *range* of binary relations, and write their notations.
2.5. What does it mean that one binary relation is the *restriction/extension* of an other? Define the *restriction* of a binary relation *to a set*, and write its notation.
2.6. Define the *inverse* of a binary relation.
2.7. Define the *image* and *inverse image* of a set under a binary relation, and write its notation.
2.8. Define the *composition* of binary relations.
2.9. Write down two properties of the composition of binary relations.
2.10. What does it mean that a relation is *reflexive*, *irreflexive*, *symmetric*, *anti-symmetric*, *strictly anti-symmetric*, *transitive*, *dichotomous* or *trichotomous*? Which of them depend only on the relation itself?
2.11. Define the *equivalence relation* and the *equivalence classes*.
2.12. Define *partitions* of a set.
2.13. What is the connection between equivalence relations and partitions?
2.14. Define *partial order* and *total order*.
2.15. Show an example for a partial order which is not a total order.
2.16. Define *strict partial order* and *strict order*.
2.17. Define the *least* and the *greatest* element.
2.18. Define the *minimal* and the *maximal* element.
2.19. Show an example for a partial ordered set which has more maximal elements.
2.20. Show an example for a partial ordered set which has no maximal elements.

3 Functions

3.1. Define the *function* and write its notations.

3.2. What is the difference between $f \in X \to Y$ and $f : X \to Y$?
3.3. What does it mean that a function is *injective*, *surjective* or *bijective*?
3.4. Write down three properties of the composition of functions.
3.5. Define the *binary* and the *unary operation*.
3.6. Write an example of a binary and a unary operation with table.
3.7. What does it mean that an operation is *commutative*, *associative*?
3.8. Define the *operation-preserving* function.

4 Complex numbers

4.1. Define the set of *complex numbers* with the *addition* and *multiplication*.
4.2. Define the *imaginary unit*.
4.3. Define the *real part* and the *imaginary part* of a complex number.
4.4. Write down the *fundamental theorem of algebra*.
4.5. Define the *conjugate* and the *absolute value* of complex numbers.
4.6. Write down the properties of complex conjugation related to addition and multiplication.
4.7. Write down the properties of absolute value related to addition and multiplication.
4.8. Define the *polar form* and the *argument* of complex numbers.
4.9. Write down the *multiplication* and *division rule* in *polar form* (i.e. the De Moivre's formulas).
4.10. Write down the *n'th power* of a complex number in polar form (De Moivre's formula).
4.11. Write down the formula for the *n'th root* of a complex number in polar form.
4.12. Define the complex n'th *root of unity*.
4.13. Write down the formula of the complex n'th roots of unity.
4.14. Define the *primitive n'th root of unity*.
4.15. If $n \in \mathbb{N}^+$ and $w \in \mathbb{C}$, write down the complex solutions of $z^n = w$, using the complex n'th roots of unity.

5 Combinatorics

5.1. Define the *permutations* of a finite set (without repetition). How many are there?
5.2. Define *permutations with repetition*. How many are there for a finite set?
5.3. Define the *variations* of a finite set (without repetition). How many are there?
5.4. Define *variations with repetition*. How many are there for a finite set?
5.5. Define the *combinations* of a finite set (without repetition). How many are there?
5.6. Define *combinations with repetition*. How many are there for a finite set?
5.7. What is a *binomial coefficient*, and what is the formula for calculating it?
5.8. Write down the *binomial theorem*.
5.9. Write down the *polynomial theorem*.
5.10. Write down the *pigeonhole principle*.
5.11. Write down the *inclusion–exclusion principle*.

6 Graph theory

6.1. Define an (undirected) *graph*.
6.2. Define *simple graphs*.
6.3. Define *adjacent* edges and vertices.
6.4. Define the *degree* of a vertex.
6.5. Define an *isolated* vertex.
6.6. Define a *regular* graph.
6.7. Write down the connection between the degrees and the number of edges.
6.8. What does it mean that two graphs are *isomorphic*?
6.9. Define *subgraphs* and *supergraphs*.
6.10. Define the *complete graph*.
6.11. Define the *complement* of a graph.

6.12. Define *bipartite* graphs.
6.13. Define *cycle graphs*, *path graphs* and *star graphs*.
6.14. Define *walks*, *trails* and *paths*.
6.15. Define *cycles*.
6.16. What does it mean that a graph is *connected*?
6.17. Define a *tree*.
6.18. Write down two different characterisations of a tree (different from the definition).