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**Semester II FINAL Examination - 2022/2023**

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**BDIC2002J/2025J Discrete Mathematics**

Exam Test A

**Time Allowed: 95 minutes**

**Instructions for Candidates**

All items within each question carry equal marks. Detailed scores are given in the table.

**BJUT Student ID: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ UCD Student ID: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

I have read and clearly understand the Examination Rules of both Beijing University of Technology and University College Dublin. I am aware of the Punishment for Violating the Rules of Beijing University of Technology and/or University College Dublin. I hereby promise to abide by the relevant rules and regulations by not giving or receiving any help during the exam. If caught violating the rules, I accept the punishment thereof.

**Honesty Pledge：\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Signature)**

**Instructions for Invigilators**

Non-programmable calculators are permitted.

No rough-work paper is to be provided for candidates.

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| **Obtained score** |
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**Question 1: Single choice question** (choose the only one item, fill the answer in bracket)

1.1 What is the function type of  **[ ]**

A、 not an injection but a surjection B、 not a surjection but an injection

C、 a bijection D、 neither an injection nor a surjection

1.2 What is the function type of  **[ ]**

A、 not an injection but a surjection B、 not a surjection but an injection

C、 a bijection D、 neither an injection nor a surjection

1.3 What is the function type of  **[ ]**

A、 not an injection but a surjection B、 not a surjection but an injection

C、 a bijection D、 neither an injection nor a surjection

1.4 Which identity is wrong **[ ]**

A、  B、 

C、  D、 

1.5 Let *R*, *S* be two equivalence relation on a finite set *A*. Which is an equivalence relation on *A*?**[ ]**

A、*R*-*S* B、*R*⊕*S* C、*R*∩*S* D、*R*∪*S*

1.6 Which tautological implication is wrong? **[ ]**

A、  B、 

C、  D、 

1.7 Which tautological implication is wrong? **[ ]**

A、  B、 

C、  D、 

1.8 Which tautological implication is wrong? **[ ]**

A、  B、 

C、  D、 

1.9 is the three-order directed complete graph. is a subgraph of obtained by deleting an edge from . Choose the graph type of . **[ ]**

A、 strongly connected graph B、 not strongly connected graph but unilaterally connected graph

C、 not unilaterally connected graph but weakly connected graph D、 none of the above

1.10 Choose the graph type of **[ ]**

A、Eulerian graph B、semi-Eulerian graph C、Hamiltonian graph

D、bipartite graph E、planar graph

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| **Obtained score** |
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**Question 2: Multiple choice question** (choose at least two items, fill the answer in bracket)

2.1 The principle disjunctive normal form of consists of [ ]

A、 B、 C、 D、

E、 F、 G、 H、

2.2 The principle disjunctive normal form of consists of **[ ]**

A、 B、 C、 D、

E、 F、 G、 H、

2.3 The principle disjunctive normal form of consists of **[ ]**

A、 B、 C、 D、

E、 F、 G、 H、

2.4 The principle conjunctive normal form of consists of **[ ]**

A、 B、 C、 D、

E、 F、 G、 H、

2.5 The principle conjunctive normal form of consists of **[ ]**

A、 B、 C、 D、

E、 F、 G、 H、

2.6 The principle conjunctive normal form of consists of **[ ]**

A、 B、 C、 D、

E、 F、 G、 H、

2.7 Let *R* be a binary relation on defined by . Choose the relation types of *R*. **[ ]**

A、reflexive B、antireflexive C、symmetric D、antisymmetric E、transitive

2.8 Let *R* be a binary relation on defined by . Choose the relation types of *R*. **[ ]**

A、reflexive B、antireflexive C、symmetric D、antisymmetric E、transitive

2.9 Let *R,S* be two binary relations on defined by . Choose the relation types of . **[ ]**

A、reflexive B、antireflexive C、symmetric D、antisymmetric E、transitive

2.10 Let *R* be a binary relation on defined by . Choose the relation types of *R*.

**[ ]**

A、reflexive B、antireflexive C、symmetric D、antisymmetric E、transitive

2.11 Let *G* be an undirected graph, with vertex number *v* and edge number *e*. Which are sufficient and necessary conditions such that *G* is a tree? **[ ]**

A、*G* is connected and has no loop B、*G* is connected and

C、*G* has no circle and D、*G* is connected and has no bridge

2.12 is the three-order directed complete graph. is a subgraph of obtained by deleting three edges from . Choose the graph type of . **[ ]**

A、 strongly connected graph B、 not strongly connected graph but unilaterally connected graph

C、 not unilaterally connected graph but weakly connected graph D、 not weakly connected graph

2.13 Choose the graph type of  **[ ]**

A、Eulerian graph B、semi-Eulerian graph C、Hamiltonian graph

D、bipartite graph E、planar graph F、non-planar graph

2.14 Choose the graph type of  **[ ]**

A、Eulerian graph B、semi-Eulerian graph C、Hamiltonian graph

D、bipartite graph E、planar graph F、non-planar graph

2.15 Choose the graph type of **[ ]**

A、Eulerian graph B、semi-Eulerian graph C、Hamiltonian graph

D、semi-Hamiltonian graph E、bipartite graph F、non-planar graph

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| **Obtained score** |
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**Question 3: Judgement question** (fill **T** (true) or **F** (false) in bracket)

3.1 For three sets , if , then **[ ]**

3.2 For three sets , **[ ]**

3.3 For any binary relation *R* on a finite set *A*, is always a symmetric relation on *A*, where denotes the composition of two relations. **[ ]**

3.4 For proposition formulae , **[ ]**

3.5 For proposition formulae , **[ ]**

3.6 For proposition functions , **[ ]**

3.7 For proposition functions , **[ ]**

3.8 Let be a simple connected graph. Then its complement is always an unconnected graph.**[ ]**

3.9 Let be an *n*-order undirected simple graph. Suppose holds for any two vertices of . Then is a Hamiltonian graph. **[ ]**

3.10 Let be a simple connected planar graph with at least a finite face. Then , where is the vertex number and is the edge number. **[ ]**

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| **Obtained score** |
|  |

**Question 4: fill-in-the-blank question**

4.1 The prenex normal form of is .

4.2 The prenex normal form of is .

4.3 The prenex normal form of is .

4.4 For arbitrary two sets *A*, *B*, let *P* denote the power set. Then (fill one symbol of “”)

4.5 Let *R* be the divide relation on *A*={2,3,4,5,6,8,10}, i.e., *xRy* iff *y=mx* for some integer *m*. Then the greatest element of the poset (*A*,*R*) is , the least element of the poset (*A*,*R*) is . The maximal elements of the poset (*A*,*R*) are , the minimal elements of the poset (*A*,*R*) are .

4.6 Let *R* be a binary relation on *A*={1,2,3,…,15,16} (i.e., *A* is the set of all positive integers 16) defined by *xRy* iff *xy* is a *square number* (i.e., 1,4,9,16,25,36,49,…). Then *R* is an equivalence relation on *A*. The cardinality of the quotient set *A*/*R* is . For any ,  .

4.7 Let *A* be a set with . Let *R* be the set of all antireflexive relations on *A*, and let *S* be the set of all antisymmetric relations on *A*. Then .

4.8 Let *A* be a set with . Let *R* be the set of all reflexive relations on *A*, and let *S* be the set of all symmetric relations on *A*. Then .

4.9 Let *A*={1,2} be a set and let *P* denote the power set. There are different bijections from *P*(*A*) to *P*(*A*). There are different surjections from *P*(*A*) to *A*.

4.10 Let *A*={1,2,3,4,5,6,7} be a set, and let *R* be a binary relation on defined by iff

. Then *R* is an equivalence relation, and .

4.11 Let *G* = . Then the length of *G*’ longest circle is . The length of *G*’s longest trail is .

4.12 has faces with odd degree. has faces with even degree.

4.13 Let *G* be an undirected graph with twelve edges. If *G* has three 2-degree vertices, two 4-degree vertices, and other vertices have odd degrees. Then  , where denotes ’s order.

4.14 After we delete at least vertices from , it becomes a graph which is both a Eulerian graph and a Hamiltonian graph.

4.15 Let *G* be a tournament whose vertex-set is . Then

= .