# Exam Paper

Here is the exam paper and a detailed marking guide based on your lecture notes.

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## \*\*Logic Fundamentals - Mid-Term Exam\*\*

\*\*Instructions:\*\*

\* Answer all questions.

\* Allocate your time appropriately.

\* Total Marks: 23

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### \*\*Section 1: Multiple Choice Questions (3 marks total)\*\*

\*Choose the best answer for each question.\*

1. Propositional logic primarily deals with:

a) Quantifiers

b) Predicates

c) Propositions that are either true or false

d) Complex numbers

2. A statement that is always true, regardless of the truth values of its components, is known as a:

a) Contradiction

b) Proposition

c) Tautology

d) Predicate

3. Predicate logic extends propositional logic by introducing:

a) Only propositions

b) Quantifiers and predicates

c) Only truth values

d) Mathematical equations

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### \*\*Section 2: Short Answer Questions (10 marks total)\*\*

\*Answer the following questions concisely.\*

1. Explain the key difference between propositional logic and predicate logic. (5 marks)

2. Define and provide a simple example for both a tautology and a contradiction. (5 marks)

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### \*\*Section 3: Essay Question (10 marks total)\*\*

\*Write a short essay addressing the following prompt.\*

1. Discuss the fundamental concepts of logic introduced in the lecture notes (propositional logic, predicate logic, tautology, and contradiction), elaborating on their definitions and interrelationships.

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## \*\*Marking Guide\*\*

### \*\*Section 1: Multiple Choice Questions (3 marks total)\*\*

\*Each correct answer is awarded 1 mark.\*

1. \*\*c) Propositions that are either true or false\*\*

2. \*\*c) Tautology\*\*

3. \*\*b) Quantifiers and predicates\*\*

### \*\*Section 2: Short Answer Questions (10 marks total)\*\*

1. \*\*Explain the key difference between propositional logic and predicate logic. (5 marks)\*\*

\* \*\*Propositional Logic (1.5 marks):\*\* Deals with simple, atomic propositions as indivisible units, assigning truth values (true/false) to these whole statements. It focuses on how propositions combine using logical connectives (AND, OR, NOT, IF...THEN, etc.).

\* \*\*Predicate Logic (1.5 marks):\*\* Extends propositional logic by allowing us to analyze the \*internal structure\* of propositions. It breaks down propositions into predicates (properties or relationships) and arguments/variables.

\* \*\*Key Difference (2 marks):\*\* The fundamental difference is the addition of \*\*quantifiers\*\* (e.g., "for all" - ∀, "there exists" - ∃) and \*\*predicates\*\* in predicate logic. This allows predicate logic to express generality, relationships, and properties of objects within a domain, which propositional logic cannot do as it treats propositions as unanalyzed wholes.

2. \*\*Define and provide a simple example for both a tautology and a contradiction. (5 marks)\*\*

\* \*\*Tautology Definition (1.5 marks):\*\* A tautology is a compound proposition that is always true, regardless of the truth values of its individual propositional components.

\* \*\*Tautology Example (1 mark):\*\*

\* "P or not P" (P ∨ ¬P)

\* "If it is raining, then it is raining" (R → R)

\* \*\*Contradiction Definition (1.5 marks):\*\* A contradiction is a compound proposition that is always false, regardless of the truth values of its individual propositional components.

\* \*\*Contradiction Example (1 mark):\*\*

\* "P and not P" (P ∧ ¬P)

\* "It is raining and it is not raining"

### \*\*Section 3: Essay Question (10 marks total)\*\*

1. \*\*Discuss the fundamental concepts of logic introduced in the lecture notes (propositional logic, predicate logic, tautology, and contradiction), elaborating on their definitions and interrelationships.\*\*

\* \*\*Introduction to Logic (1 mark):\*\* Briefly state that logic provides a formal system for reasoning and analyzing arguments, and the concepts discussed are foundational to this study.

\* \*\*Propositional Logic (2 marks):\*\*

\* \*\*Definition:\*\* Explain that it's the basic form of logic dealing with atomic propositions (statements that are definitively true or false).

\* \*\*Scope:\*\* Focuses on the truth values of entire statements and how these combine using logical connectives.

\* \*\*Limitation (briefly):\*\* Cannot analyze the internal structure of propositions.

\* \*\*Predicate Logic (3 marks):\*\*

\* \*\*Definition:\*\* Explain that it extends propositional logic by allowing for more detailed analysis.

\* \*\*Key Elements:\*\* Introduces \*\*predicates\*\* (properties or relationships) and \*\*quantifiers\*\* (universal 'for all' (∀) and existential 'there exists' (∃)).

\* \*\*Extension:\*\* Emphasize that it overcomes propositional logic's limitation by allowing statements like "All students are intelligent" or "There exists a red car" to be formally represented and reasoned about. It allows for reasoning about objects and their properties/relationships.

\* \*\*Tautology (2 marks):\*\*

\* \*\*Definition:\*\* A statement that is always true, irrespective of the truth values of its components.

\* \*\*Significance:\*\* Represents a logically valid statement or a fundamental truth within the system. Used to prove equivalence or validity.

\* \*\*Contradiction (1.5 marks):\*\*

\* \*\*Definition:\*\* A statement that is always false, irrespective of the truth values of its components.

\* \*\*Significance:\*\* Represents a logically impossible statement. Often used in proof by contradiction.

\* \*\*Interrelationships/Conclusion (0.5 marks):\*\*

\* \*\*Relationship between Tautology/Contradiction:\*\* They are logical opposites (a contradiction is the negation of a tautology, and vice-versa).

\* \*\*Relationship to Logic Systems:\*\* Both propositional and predicate logic seek to identify tautologies (valid arguments) and avoid contradictions (invalid arguments). Predicate logic simply provides a more powerful framework to do so for a broader range of statements. Conclude by reiterating the importance of these concepts in building a robust system for logical reasoning.

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