



MULUNGUSHI UNIVERSITY

Pursuing the frontiers of knowledge

School of Science Engineering and Technology

Department of Computer Science and IT

ICT312-Introduction to Compilers

Duration: 3hrs

2023/2024 Academic Year - Semester 2

Final Examination

INSTRUCTIONS TO CANDIDATES

1. The total marks for this paper is 100.
2. This paper has two Sections Section A and Section B
3. Answer all questions in Section A. Total marks for Section A is 40 marks
4. There are four (4) questions in Section B, answer ONLY three (3) questions. Total marks for Section B is 60 marks
5. Present readable and tidy work
6. Begin every question on a new page of the answer booklet.
7. Indicate your Student Number and NRC number on the answer booklet provided.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

Section A [Compulsory Question - 40 marks]

Question 1

- a) Consider the expression $result = (value1 + value2) * factor - offset/(value1 + value2)$. Identify the lexemes and produce the output at each of the six phases of the compiler shown below. (16 marks)
- Lexical Analysis (3 marks)
 - Syntax Analysis (3 marks)
 - Semantic Analysis (3 marks)
 - Intermediate Code Generation (3 marks)
 - Code Optimization (2 marks)
 - Code Generation (1 mark)
- b) Describe an LL(1) parser (4 marks)
- c) What are the five qualities that you, as a user, consider most important in a compiler that you purchase? (10 marks)
- d) Define ambiguous grammar? (5 marks)
- e) Test whether the following grammar is ambiguous or not. (5 marks)
 $E \rightarrow E+E | E-E | E^*E | E/E | E \uparrow | (E) | -E | id$

Section B [60 marks Answer Any Three Questions]

Question 2 [20 marks]

- a) Given the following grammar below compute the following

$$\begin{array}{l} S \rightarrow E\$ \\ E \rightarrow TE' \\ E' \rightarrow +TE' \\ E' \rightarrow -TE' \\ E' \rightarrow \epsilon \\ T \rightarrow FT' \\ T' \rightarrow *FT' \\ T' \rightarrow /FT' \\ T' \rightarrow \epsilon \\ F \rightarrow id \\ F \rightarrow num \\ F \rightarrow (E) \end{array}$$

- First and Follow sets (10 marks)
- Parsing table (10 marks)

Question 3 [20 marks]

- Describe left recursion in context-free grammars.(5 marks)
- List and explain the two different types of left recursion giving an example for each.(4 marks)
- Consider the following grammar below.
$$E \rightarrow E + T \mid TT \rightarrow T * F \mid FF \rightarrow (E) \mid id$$
 - Eliminate the left recursion from the grammar.(9 marks)
- State the limitations of recursive descent parser?(2 marks)

Question 4 [20 marks]

- Design an NFA for a language that accepts all strings over $\{0,1\}$ in which the second last symbol is always '1'.(10 marks)
- Convert the NFA into an equivalent deterministic finite state machine (DFA). (10 marks)

Question 5 [20 marks]

Errors in a computer program can be classified according to when they are detected and, if they are detected at compile time, what part of the compiler detects them. Using your favorite programming language, give an example of the following errors.

- A lexical error, detected by the scanner recognizing the lexical tokens of the language. (4 marks)
- A syntax error, detected by the parser recognizing the parse tree for a program. (4 marks)
- A static semantic error (i.e., a contextual constraint) detected during the semantic analysis of a program. (4 marks)
- A dynamic (semantic) error, detected at run time by code generated by the compiler. (4 marks)
- An error in the correctness of a program that the compiler may not catch. [Depending on the programming language, the error may be or it may not be a violation of the language definition.] (4 marks)

END OF EXAMINATION