



TECHNICAL UNIVERSITY OF MOMBASA

UNIVERSITY EXAMINATION FOR
BACHELOR OF SCIENCE IN COMPUTER SCIENCE

CCS 4101: COMPILER CONSTRUCTION

END OF SEMESTER EXAMINATION

SERIES: MARCH 2025

TIME: 2 HOURS

DATE: 31 OCTOBER, 2024

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of questions. Attempt.

Do not write on the question paper.

Question 1

- a) What advantages are there to a language processing system in which the compiler produces assembly language rather than machine language [2 marks]
- b) State the two basic requirements for a grammar in compiler construction. [2 marks]
- c) Define the following terms [4 marks]
 - i. Language
 - ii. Sentence
 - iii. Grammar
 - iv. Token
- d) Identify three types of errors that cannot be detected at syntax analysis phase but can be identified by semantic analysis phase [4 marks]
- e) Briefly explain the various phases of a compiler [6 marks]
- f) Given the grammar below, construct a parse tree for the string $w = cad$ [2 marks]

$S \rightarrow cAd$

$A \rightarrow ab \mid a$

- g) Explain the difference between S-attributed and L-attributed SDTs [4 marks]
- h) Explain the roles of the frontend and backend of a compiler [4 marks]

Question 2

- a) Explain the two major categories of Intermediate Representation (IR) giving appropriate use cases for each category [6 marks]
- b) Compare and contrast three-address code and abstract syntax trees (ASTs) as intermediate representations [6 marks]
- c) Generate a lexical analyzer output for the expression $z = a + b * 20$ [4 marks]
- d) Identify the tasks typically performed during semantic analysis [4 marks]

Question 3

- a) Explain the two major types of derivations in syntax analysis and use the grammar $G: E \rightarrow E + E \mid E * E \mid (E) \mid -E \mid b$ and sentence $-(b+b)$ to illustrate the derivation of each type. [8 marks]
- b) Explain any two differences between regular expressions and context-free grammars [4 marks]
- c) Explain the difference between top-down parsing and bottom-up parsing. State one use case for each parsing method. [6 marks]
- d) Explain the importance of precedence and associativity in grammars for shift-reduce parsing [2 marks]

Question 4

- a) Explain the concept of ambiguity in grammars and illustrate how ambiguity affect parsing. [4 marks]

b) Consider the following grammar for parsing simple arithmetic expressions with unary minus and answer the following questions

$$E \rightarrow E + T \mid E - T \mid T$$
$$T \rightarrow T * F \mid T / F \mid F$$
$$F \rightarrow -F \mid (E) \mid \text{num}$$

- i. Given the input string "5 * (4 - 2)", perform a shift-reduce parsing using the given grammar [4 marks]
 - ii. Generate a parse tree for the input string in Question 4b(i) above [4 marks]
 - iii. Identify any ambiguities in the grammar and suggest how they could be resolved to ensure a unique parse. [4 marks]
- c) Discuss any potential optimizations or enhancements that could be made to the grammar or parsing algorithm to improve efficiency [4 marks]

Question 5

- a) Describe the process of tokenization in lexical analysis [4 marks]
- b) Discuss the challenges of generating efficient code for different target architectures [6 marks]
- c) Explain the role of intermediate code in the compilation process [4 marks]
- d) Construct a DAG for the following three address code [6 marks]

$$a = b + c$$
$$t1 = a \times a$$
$$b = t1 + a$$
$$c = t1 \times b$$
$$t2 = c + b$$
$$a = t2 + t2$$