



NATIONAL OPEN UNIVERSITY OF NIGERIA
University Village, 91 Cadastral Zone, NnamdiAzikwe Expressway, Jabi, Abuja
FACULTY OF SCIENCES
COMPUTER SCIENCE DEPARTMENT
2023_1 POP EXAMINATION.

COURSE CODE: CIT 342
COURSE TITLE: Formal Languages and Automata Theory
CREDIT: 3 Units
TIME ALLOWED: 3 Hours
INSTRUCTION: Answer Question One (1) and any other three (3) questions

- 1a) What is a sentential form? (2 marks)
- b) Consider the linear grammar: $\{S, B\}, \{a, b\}, S, \{S \rightarrow aS, S \rightarrow B, B \rightarrow bB, B \rightarrow \lambda\}$. Give any four sentential form of this grammar (4 marks)
- c) Describe the various components of a formal grammar. (6 marks)
- d) In the context of theoretical computer science, define *automata theory*? (3 marks)
- e) What do you understand by leftmost and rightmost derivation of a grammar? Are they the same? (6 marks)
- f) When is a grammar said to be in **Chomsky normal form**? (4 marks)
- 2a) Consider the grammar: $G = (\{S, A, B, C\}, \{a, b, c\}, S, P)$ where $P = \{S \rightarrow ABC, A \rightarrow aA, A \rightarrow \lambda, B \rightarrow bB, B \rightarrow \lambda, C \rightarrow cC, C \rightarrow \lambda\}$, derive the string **abbc** in a
- i) leftmost derivation (4 marks)
- ii) rightmost derivation (4 marks)
- b) Draw the derivation tree for the leftmost derivation in question (2a) above. (2 marks)
- c) Prove that the context-free languages are closed under the formation of union. (5 marks)
- 3a) In the context of automata theory, explain the following terms:
- i. Recognised language)
- ii. Run) **2 marks each**
- iii. Transducer)
- b) Enumerate the different ways of using a grammar.) **5 marks**
- c) Write short notes on the concept of ambiguity in grammars.) **4 marks**
- 4a) What is meant by *inherently ambiguous language*? (2 marks)
- b) Distinguish between a word and a vocabulary in formal language. Illustrate your answer with examples) **5 marks**
- c) What is a Pushdown Automata (PDA)) 4 marks
- d) Prove that for any regular language there is a DPDA that accepts it (4 marks)

- 5a) When is a grammar said to be in *Greibach Normal Form*? (3 marks)
 - b) What are the characteristics of grammars that are in *Greibach Normal Form*? 2 marks
 - c) State the use(s) of Greibach Normal Form (2 marks)
 - d) Formally define Type 1 grammar) 3 marks
 - e) Briefly describe the different types of PDAs.) 5 marks
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- 6a) List the three different ways a language can be defined) 3 marks
 - b) Is an NFA more powerful than a DFA? Explain (4 marks)
 - c) State Godel incompleteness theorem) 2 marks
 - d) What do you understand by context-sensitive grammars?) 2 marks
 - e) When is formal system said to be:
 - i) Complete?)
 - ii) Inconsistent?) 2 marks each