NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI, ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF COMPUTER SCIENCE
OCTOBER, 2019 EXAMINATIONS

COURSE CODE: CIT342
COURSE TITLE: FORMAL LANGUAGES AND AUTOMATA THEORY
COURSE CREDIT: 3 UNITS
TIME ALLOWED: 2½ HOURS
INSTRUCTION: ANSWER QUESTION 1 AND ANY OTHER FOUR (4) QUESTIONS

1a) Distinguish between the strings and the words of a language ***(2 marks)***
b) Compare Non-Determinism to Determinism. Which of them is ideal for use in a computer system? ***(4 marks)***
c) Differentiate between Kleene Star Closure (*) and Plus (+) operations over the alphabet of a grammar.***(4 marks)***
d) Explain any three (3) Applications of Finite Automata ***(9 Marks)***
e) Give regular expressions that generate each of the following languages. In all cases, the alphabet is
$\Sigma = \{a, b\}$. (a).
(i) The language $\{w \in \Sigma^* \mid |w| \text{ is odd}\}$. ***(1 mark)***
(ii) The language $\{w \in \Sigma^* \mid w \text{ has an odd number of a's}\}$. ***(1 mark)***
(iii) The language {w | w contains at least two a's, or exactly two b's ***(1 mark)***

2a) Using the Set language, define the following terms and concepts: ***(9 marks)***
(i) Union (ii) Intersection (iii) Set Concatenation (iv) Kleene-star, (v) Set Subtraction (vi) Complement
(b) State regular expressions that generate each of the following languages. In all cases, the alphabet is $\Sigma = \{a, b\}$. (a).
i) The language $\{w \in \Sigma^* \mid w \text{ ends in a double letter }\}$. ***(1 mark)***
ii) The language $\{w \in \Sigma^* \mid w \text{ does not end in a double letter}\}$. ***(1 mark)***
iii) The language $\{w \in \Sigma^* \mid w \text{ contains exactly one double letter}\}$. ***(1 mark)***

3a) Briefly explain the following:

(i) Turing-decidable language ***(3 marks)***

(ii) Turing-recognizable language ***(2 marks)***

b) State the characteristics of grammars 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)***

4a) Define context-sensitive grammars ***(2 marks)***

b) What do you understand by decision problems? ***(3 marks)***

c) What do you understand by the term *automata theory*? ***(2 marks)***

d) Define leftmost and rightmost derivation of a grammar. State the distinction between the two. ***(5 marks)***

5a) Consider the grammar: G = ({S, A, B, C}, {a, b, c}, S, P)

Where, P = {S→ABC, A→aA, A→λ, B→bB, B→λ, C→cC, C→λ}, derive the string ***abbc*** in a:

i) leftmost derivation ***(2 marks)***

ii) rightmost derivation ***(2 marks)***

b) Draw the derivation tree for the leftmost derivation in question (5a) above. ***(3½ marks)***

c) When is a grammar said to be in **Chomsky normal form?** ***(4½ marks)***

6a) Prove that context-free languages are closed under the formation of union. ***(6 marks)***

b) In the context of automata theory, briefly describe the following terms:

i. Recognised language ***(2 marks)***

ii. Run ***(2 marks)***

iii. Transducer ***(2 marks)***