



**THE CO-OPERATIVE UNIVERSITY OF KENYA**  
**END OF SEMESTER EXAMINATION DECEMBER -2022**  
**EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER**  
**SCIENCE**  
**(YR III SEM I)**  
**UNIT CODE: BCSC 3155**  
**UNIT TITLE: AUTOMATA THEORY**  
**DATE: THURSDAY, 15<sup>TH</sup> DECEMBER, 2022**  
**TIME: 9:00 AM – 11:00 AM**

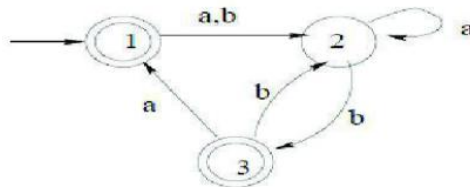
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**INSTRUCTIONS:**

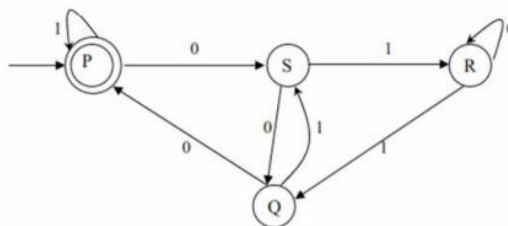
- Answer question ONE (compulsory) and any other TWO questions

**QUESTION ONE (30 MARKS) - COMPULSORY**

- (a) Define the following terms
- i. Alphabet (1 mark)
  - ii. Turing Machine (TM) (1 mark)
  - iii. Regular Grammar (1 mark)
  - iv. DFA (1 mark)
- (b) Explain P and NP problems (3 marks)
- (c) Convert the following Finite Automata into its equivalent regular expression (3 marks)



- (d) Generate grammar for Regular Expression  $0^*1(0+1)^*$ . (4 marks)
- (e) Construct PDA which accepts the language  $L = \{a^n b^n \mid n \geq 0\}$  (4 marks)
- (f) State whether the following Language is Regular or not.
- i)  $L = \{WW^R \mid |W|=2 \text{ over } \Sigma = \{a, b\}\}$
  - ii)  $L = \{WW^R \mid W \in (a, b)^*\}$  (4 marks)
- (g) Draw a DFA to accept strings of a's and b's starting with the string ab. (4 marks)
- (h) Convert the following DFA to Regular Expression (4 marks)



## QUESTION TWO (20 MARKS)

- (a) Give formal definition of a Universal Turing Machine. (5 marks)
- (b) Write a regular expression for the following languages, over  $\Sigma = \{a,b\}$ .
- i) Seventh symbol from right must be a. (4 marks)
  - ii) Every second character is b. (3 marks)
  - iii) Exactly one ab. (3 marks)
- (c) Explain the Chomsky Hierarchy. (5 marks)

## QUESTION THREE (20 MARKS)

- (a) State ANY SIX application of Finite Automata (6 marks)
- (b) Construct a TM for accepting Even palindromes. (7 marks)
- (c) Design PDA for recognizing  $L = \{a^n b^{2n+1} \mid n \geq 1\}$  (7 marks)

## QUESTION FOUR (20 MARKS)

- (a) Explain the Moore and Mealy Machines (4 marks)
- (b) What is Unit production? If you eliminate the unit production from given CFG, what will be the effect on the language by the resultant grammar? (4 marks)
- (c) Convert the following grammar to Chomsky Normal Form. Show all the relevant steps briefly.
- $S \rightarrow bA \mid aB$   
 $A \rightarrow bAA \mid aS \mid a$   
 $B \rightarrow aBB \mid bS \mid b$  (5 marks)
- (d) Explain the Recursive and Recursively enumerable languages. (5 marks)

## QUESTION FIVE (20 MARKS)

- (a) Explain properties of an Ambiguous CFG (2 marks)
- (b) Explain Decidability problems (3 marks)
- (c) Enumerate the differences between finite automata and non-deterministic automata? (5 marks)
- (d) Construct DFA for the regular Expression  $R = ab(a+b)^+abb$ . Obtain minimized DFA. (5 marks)
- (e) Give formal definition of a Push Down Automata (PDA). (5 marks)