

Theory of Automata (CS3005)

Date: June 5th 2025

Course Instructor(s)

Dr. Tahir Ejaz

Final Exam **Solution**

Total Time (Hrs): 2.5

Total Marks: 44

Total Questions: 4

Roll No

Section

Student Signature

1. Rough sheets are *allowed* but you are **required to write solution in the provided space**.
2. **Do not** submit the rough sheets.

CLO # 3: Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on context-free languages using automata (PDA and NPDA).

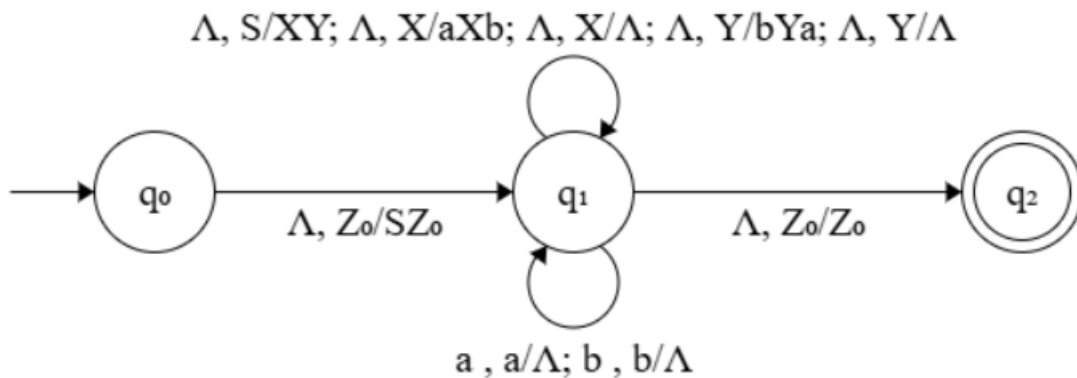
Q1: Draw the transition diagram of a Pushdown Automata (not necessarily deterministic) for the following language:

$$\{a^n b^{m+n} a^m \mid n, m \geq 0\}$$

Note: The number of states of your PDA must not exceed 3.

Hint: Every CFG has a corresponding 3 state PDA.

[15 Marks]



X generates $a^n b^n$, and Y generates $b^m a^m$; hence, XY generates $a^n b^{n+m} a^m$.

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CLO # 4: Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on non context-free languages using Turing Machines

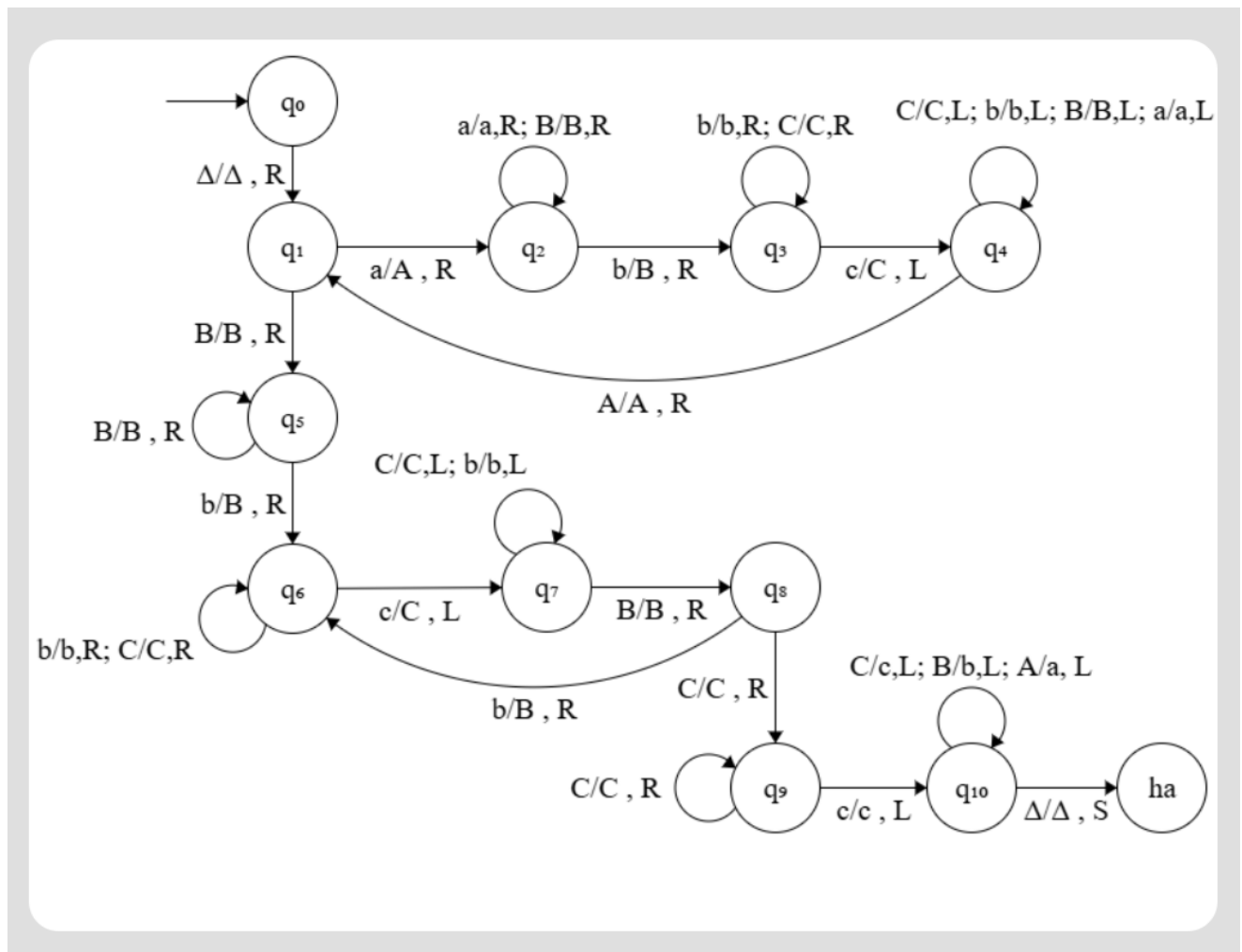
Q2: Draw a transition diagram for a (single-tape, deterministic) Turing machine that accepts the following language:

$$L = \{a^i b^j c^k \mid 0 < i < j < k\}$$

Your machine must **not** enter in an **infinite loop**.

Note: For the sake of simplicity, assume that the input has the form $aa^*bb^*cc^*$.

[15 Marks]

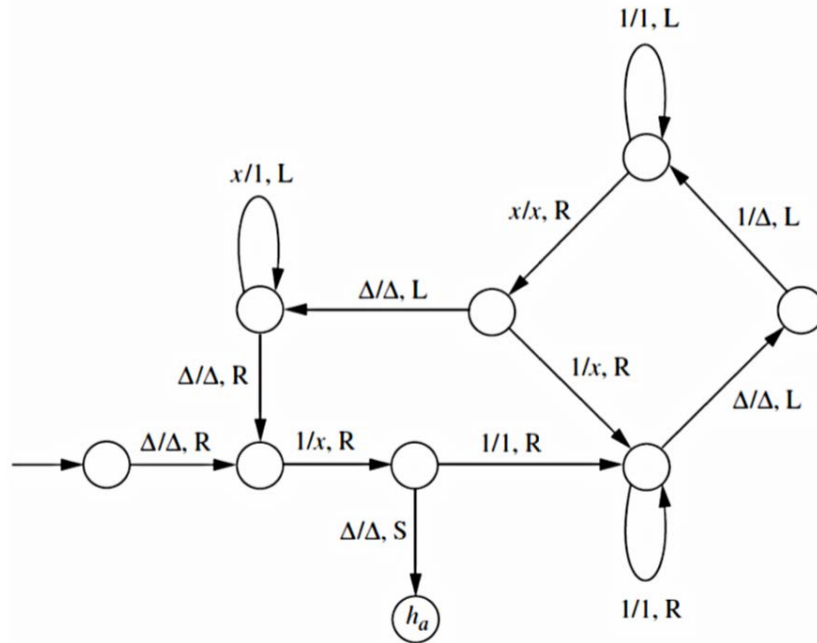


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Q3: Describe the language (a subset of $\{1\}^*$) accepted by the TM in the following Figure:

[7 Marks]



Answer:

$$L = \{w \in \{1\}^* \text{ such that } |w| \text{ is a power of } 2\}$$

CLO # 1: Identify formal language classes and prove language membership properties. Prove and disprove theorems establishing key properties of formal languages and automata

Q4: Using pumping lemma, we want to show that the following language L is not a regular language.

$$L = \{a^i b^j c^j \mid i \geq 1 \text{ and } j \geq 0\}$$

Let the pumping lemma constant be n (i.e. let's assume that there is an FA comprising of n states that accepts L); then what string should we choose to arrive at a contradiction? *Informally* describe why your chosen string should work.

[7 Marks]

Answer: $ab^n c^n$

Justification: If v contains a , then $uv^0w \notin L$; else, v must consist of b 's only, and uv^2w has more b 's than c 's.