

Q1. [10 pts] Design CFG for the language of balanced parenthesis = $\{\Delta, (), ()(), (()), (()())....\}$

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Q2. [10 pts] Design PDA for the language EQUAL-EQUAL = { Δ , ab, ba, aabb, bbaa, abab, baba, baab, abba, aaabbb, }

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Q3. [1+2+2+3+2 = 10 pts] Convert to CNF and you must show all the intermediary four steps in the order studied to score full marks:

S \rightarrow SS | AB | B

A \rightarrow aAAa

B \rightarrow bBb | bb | Δ

C \rightarrow CC | a

D \rightarrow aC | bb

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Q4. [5+5 = 10 pts] Convert to GNF. You must convert to intermediary grammar to get full marks.

$S \rightarrow AB$

$A \rightarrow AB \mid a$

$B \rightarrow AB \mid a$

Q5. [10 pts] Prove if $a^n b^n c^n d^n$ is a non-CFL.

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Q6. [10 pts] Let L be some regular language in which all the words happen to have an even length. Let us define the new language $\text{Twist}(L)$ to be the set of all the words of L twisted, whereby twisted we mean the first and second letters have been interchanged, and so on. For example, if

$L = \{ \text{ba abba babb } \dots \}$

$\text{Twist}(L) = \{ \text{ab baab abbb } \dots \}$

Build a Turing Machine that accepts $\text{Twist}(L)$. You are also **allowed** to use the sub programs of **INSERT** and **DELETE**. You may assume after **INSERT** operation, tape head points at the newly added cell while after **DELETE** operation, tape head points at the same location. You may leave the tape head at any location on the output string when the computation is done.

Status of tape on input is:

#	a	b	b	b	a	b	a	A	Δ	Δ	Δ	.	.
---	---	---	---	---	---	---	---	---	----------	----------	----------	---	---



Status of tape at the output is:

#	b	a	b	b	b	a	a	a	Δ	Δ	Δ	.	.
---	---	---	---	---	---	---	---	---	----------	----------	----------	---	---



Q7. [10 pts] For the language $a^n b^{2n} c^{2n} d^n e^n$, where $n \geq 0$, design a 2-PDA.

Q8. [10 pts] Design a Post Machine for the language **EVEN-EVEN**.

