Middle East Technical University | Department of Computer Engineering

CENG 280

Formal Languages and Abstract Machines

Spring '2015-2016

Take Home Exam 2

Due date: 23 April 2016, 23:55

Question 1

(a) Give the description of the language generated by the following CFG

S → AB | C

A → xAy | e

B → zB | e

C → xCz | D

D → yD | e

(b) Give the description of the language generated by the following CFG

S → UV

U → xUx | yUy | $V

V → xV | yV | e

(c) Give a regular expression, if possible, for the language generated by the following CFG

S → A | B

A → AAAAAAAAAA | x

B → zC | yC | e

C → zB | yB

Question 2

Prove whether the following languages are context free or not.To prove that a language is context free, give the associated CFG. To prove that a language is not context free, use Pumping Lemma for CFL. You may also use closure properties.

(a) L_1=$\{\ aa^R 2^{|a|}$: a $\in \{1,2\}^*\ \}$

(b) $L_2 = A \setminus B$ such that A= $\{\ x^n y^m z^k$: k,n,m ≥ 0 and k=n+m $\}$ and B= $\{x^n y^m | 0 \leq n, m \leq 100\}$

(c) L_3= $\{\ a^n b^m c^{n*m}$: n,m $\geq 0\ \}$

(d) L_4=$\overline{L}$ such that L= $\{\ 1^n 2^m : 0 \leq n \leq m \leq 2n\ \}$

Question 3

(a) Let L= $\{\ w \in \{0,1\}^*$: the first, middle and last elements of w are same and the length of w is odd$\}$.

Construct a PDA M that accepts L.

(b) Trace the computation of the string 01000 in M

(c) Show that 00100 $\notin L(M)$

Question 4

(a) Assume L_1 and L_2 are context free languages, and R is a regular language. Decide whether the following languages are context free (CFL) or not. Explain.

- $L_1 \cup (L_2 \setminus R)$
- $R \setminus (L_1 \cup L_2)$

(b) Given a Context Free Grammar G,

S $\rightarrow$ XY | xxY

X $\rightarrow$ x | Xx

Y $\rightarrow$ y

Is G ambiguous ? Explain in detail and draw the associated parse trees.

(c) Let M be a PDA with 2 stacks and N be a PDA with 1 stack. Give a language that can be recognized by M, but not recognized by N, and explain clearly. Is M more powerful than N ? Explain.

1 Regulations

1. You have to write your answers to the provided sections of the template answer file given. Other than that, you cannot change the provided template answer file. If a latex structure you want to use cannot be compiled with the included packages in the template file, that means you should not use it.

2. Do not write any other stuff, e.g. question definitions, to answers' sections. Only write your answers. Otherwise, you will get 0 from that question.

3. **Late Submission: 3 days in total**

4. **Cheating: We have zero tolerance policy for cheating**. People involved in cheating will be punished according to the university regulations.

5. **Newsgroup:** You must follow the newsgroup (news.ceng.metu.edu.tr) for discussions and possible updates on a daily basis.

6. **Evaluation:** Your latex file will be converted to pdf and evaluated by course assistants. The .tex file will be checked for plagiarism automatically using "black-box" technique and manually by assistants, so make sure to obey the specifications.

2 Submission

Submission will be done via COW. Download the given template file, "the2.tex", when you finish your exam upload your "the2.tex" file to COW.
Note: You cannot submit any other files. Don't forget to make sure your .tex file is successfully compiled in Inek machines using the command below.

```
$ pdflatex the2.tex
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