

CENG 280

Formal Languages and Abstract Machines

Spring 2022-2023

Homework 5

Due date: 22 05 2023, Monday, 23:55

Question 1 (20 points)

$G_1 = \{V, \Sigma, R, S\}$ where $V = \{0, 1, S, A, B\}$, $\Sigma = \{0, 1\}$ and R is;

$S \rightarrow A|B$

$A \rightarrow 0A1|\epsilon$

$B \rightarrow 1B0|\epsilon$

a) (10 points) What does G_1 represent? Answer with one sentence.

b) (10 points) Is G_1 ambiguous? If yes, why?

Question 2 (30 points)

$G_2 = \{V, \Sigma, R, S\}$ where $V = \{a, b, S, A, B\}$, $\Sigma = \{a, b\}$ and R is;

$S \rightarrow AB$

$A \rightarrow aA|a|\epsilon$

$B \rightarrow bB|b|\epsilon$

a) (10 points) Show that G_2 is ambiguous.

b) (10 points) Give an unambiguous grammar for $L(G_2)$.

c) (10 points) Give the leftmost derivation of the string $abbb$ from the grammar you have constructed for part b and draw the corresponding parse tree.

Question 3 (50 points)

a) (30 points) Show that the following languages are deterministic context-free.

i) $L_1 = \{ca^mb^n \mid m \neq n\} \cup \{da^mb^{2m} \mid m \geq 0\}$

ii) $L_2 = \{a^mcb^n \mid m \neq n\} \cup \{a^mdb^{2m} \mid m \geq 0\}$

b) (20 points) Consider the following classes of languages:

- i) Regular
- ii) Context-free
- iii) The class of the *complements* of context-free languages
- iv) Deterministic context-free

Give a Venn diagram of these classes, so that inclusions, intersections, etc. of classes are reflected accurately.

Specifications

- **Deadline:** The deadline for this homework is strict and no late submissions will be accepted. Submission deadlines are **not** subject to postponement.
- **Grading:** “sufficiently reasonable” solutions will get full credit for the subject question, even if it is partially incorrect. Rough criteria for a solution to be sufficiently reasonable are being the student’s original answer and at least partially relying on a correct approach/method even if the application is not totally correct.
- **Cheating:** Any type of cheating or extensive collaboration is strictly prohibited. In case of cheating, the cheater’s all homeworks will be graded zero (0); further, university regulations about cheating will be applied.
- **Updates:** Follow the course page on ODTUClass for any updates and clarifications. Please ask your questions on ODTUClass instead of e-mailing if they do not contain some part of the solution. Otherwise, you can send an email to “mduymus@ceng.metu.edu.tr” and/or “mferhata@ceng.metu.edu.tr”.

Submission

Submissions will be done via ODTUClass. You are expected to submit a single **searchable/vectorized** PDF file named “HW5_yourStudentID.pdf (e.g. HW5_1234567)”. Submissions violating the naming convention will be penalized. Also write your name and student ID number to the top of your solution sheets. A grade reduction will be applied to the solution sheets without a name and ID on them.