

# TCS II

## Formal Languages and Computability 2020/21

### 2nd Midterm

1. June 2021

Solve the assignments on your own.

Time limit is 60 minutes.

Good luck!

ASSIGNMENT	POINTS	OUT OF	ASSIGNMENT	POINTS	OUT OF
1			2		
3			4		

FIRST AND LAST NAME: \_\_\_\_\_

STUDENT ID: \_\_\_\_\_

SIGNATURE: \_\_\_\_\_

**1. Assignment:** (30 points)

Let's define the language:

$$L_1 = \{0^{2n}1^n \mid n \geq 0\}$$

QUESTIONS:

1. Construct a TM for  $L_1$ . For the TM, write down the 7-tuple defining it!
2. Using the Instantaneous descriptions (IDs), show how your TM accepts the input string 000011.

**2. Assignment:** (25 points)

You are given the following context free grammar (CFG)  $G$ ,  $\Sigma = \{x, y, z\}$ :

$$\begin{aligned} S &\rightarrow XYZ \mid YZ \\ X &\rightarrow xX \mid y \\ Y &\rightarrow x \mid X \\ Z &\rightarrow z \\ W &\rightarrow xX \mid yy \mid z \end{aligned}$$

**QUESTIONS:**

1. Turn this grammar into Chomsky Normal Form (CNF).
2. Using the CYK algorithm, check if the word  $xyxz$  is in the language defined by grammar  $G$ .

**3. Assignment:** (20 points)

You are given the following 4 string pairs of a Modified Post Correspondence Problem (*MPCP*) – numbered from 1. to 4.:

1.  $(a, ab)$
2.  $(b, ca)$
3.  $(ca, a)$
4.  $(abc, c)$

QUESTIONS:

1. Reduce the given *MPCP* to a *PCP*.
2. Find a solution to the given *MPCP* and show how this solution reduces to the solution of the *PCP*.

**4. Assignment:** (25 points)

You are given the following Boolean (or logical) expression ( $A$ ,  $B$  and  $C$  are boolean variables; *concatenation*,  $+$  and  $-$  represent the operations *AND*, *OR* and *NOT*, respectively):

$$A + B(-C)$$

**QUESTIONS:**

1. Convert the given Boolean expression first to Conjunctive Normal Form (CNF) and then to 3-Conjunctive Normal Form (3-CNF) (if needed).
2. Reduce this 3-SAT problem (from the previous conversion into 3-CNF) to the Vertex Cover (VC) problem – find a satisfying assignment to the 3-CNF and the vertex cover of the related graph.