

# CENG 280

## Formal Languages and Abstract Machines

Spring 2022-2023

### Homework 6

---

Due date: 7th of June, 2023, Wednesday, 23:55

#### Question 1 (15 points)

Alan Turing was born in June 23 1912 and died in June 7 (i)\_\_\_\_\_.

Turing played a crucial role in breaking the (ii)\_\_\_\_\_ code during World War II.

The now-famous (iii)\_\_\_\_\_, proposed in his paper Computing Machinery and Intelligence (1950), is an attempt to define a standard for a machine to be called "intelligent".

One of his most-cited works, titled (iv)\_\_\_\_\_ was published in 1952, which proposed a mechanism as to how inhomogeneous patterns in nature arise from symmetric starting states.

The 2014 movie titled (v)\_\_\_\_\_ aims to give a biographical portrait of Turing.

#### Question 2 (50 points)

Give a semidecider for the language  $a^*ba^*b$  by

- a) Using the Formal Definition of TMs in our textbook 4.1.1.  
*Note:* You are expected to provide a diagram/drawing of the resulting TM.
- b) Using combination of Basic Machines e.g  $L, R, M_a$  etc.

#### Question 3 (35 points)

**Integer Exponentiation.** Construct a Turing machine that computes the integer exponentiation. Your machine will have three tapes. The first tape will start with  $a$  and  $b$ , both represented in binary, separated by a comma. The machine will compute  $a^b$  in binary. You can assume you already have access to and call Turing machines  $M_+$ ,  $M_\times$ , and  $M_-$  which add, multiply, and subtract two numbers respectively.

*Note:* Your answer need not be, nor is expected to be formal. Just make sure that you define an algorithmic procedure computing  $a^b$ . See the descriptions of the TMs in p.206 and p.225 in the textbook to get a sense of the expected level of detail.

*Note:* You can assume any form of operation (such as where it takes the input from, or where it outputs the computed quantity) for the Turing machines  $M_+$ ,  $M_\times$ ,  $M_-$ .

## 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 “bugra@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 “HW6\_yourStudentID.pdf (e.g. HW6\_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.