	Fac. Number	Group	Course	Speciality	
Name:					

Technical University Sofia
Faculty for German Engineering and Business Economics
F D I B A

Klausur: Informatik III

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- Problem 1. Multiple Choice 10 Points
- Problem 2. Subset Construction , Minimal Automaton 11 Points
- Problem 3. Contextfree Grammars 13 Points
- Problem 4. Pumping Lemma 12 Points
- Problem 5. Decidability 8 Points
- Problem 6. Complexity 6 Points

Attention:

- There is only one free sheet for your calculations and notes.
- Write on all sheets your names and faculty number.
- The examination contains 8 sheets and you will pass if you collect 20 points.

Problem:	1	2	3	4	5	6
Max Points:	10	11	13	12	8	6
Points:						

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Problem 1. Multiple choice

10 Points

Indicate whether the following statements are true or false by marking the correct answer.
Attention!
Every correct answer gives you one point. For each wrong answer one point will be taken off.
Empty answers are evaluated with 0 points. The entire problem is never evaluated with a negative score.

1. If a language $L \subseteq \{a, b\}^*$ is regular, then the language $L^R = \{w^R \mid w \in L\}$ is also regular.

   correct/wrong

2. Let L be undecidable. Then the index of the Nerode relation of L is infinite.

   correct/wrong

3. Contextfree languages are closed under complement.

   correct/wrong

4. Pushdown automata accept the languages of type 2.

   correct/wrong

5. Linear bounded nondeterministic Turing machines (LBA) accept the conextsensitive languages.

   correct/wrong

6. For all semi-decidable languages L_1 and L_2, the language $L_1 \setminus L_2 = \{w \in L_1 \mid w \notin L_2\}$ is also semi-decidable.

   correct/wrong

7. The Ackermann function is Loop-computable.

   correct/wrong

8. The Turing-computable functions are exactly the WHILE computable functions.

   correct/wrong

9. Every semi-decidable set is recursively enumerable.

   correct/wrong

10. Let L be **NP**-complete. Then: $L \in \mathbf{P} \Longrightarrow \mathbf{P} = \mathbf{NP}$.

    correct/wrong

    For all problems, **P** and **NP** are complexity classes.

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Problem 2. Subset construction, minimal automaton

4+7 Points

(a) Construct a finite automaton in the alphabet $\{0, 1\}$ which accepts exactly the words in $\{1, 10, 101\}^*$.

(b) Find a minimal deterministic finite automaton which is equivalent to the following nondeterministic automaton:

$A = (Q, \Sigma, s, F, \delta)$, where $Q = \{s, p, q, r\}, \Sigma = \{0, 1\}, F = \{s\}$ and

$\delta(s, 0) = \{s, p, q\},\ \delta(p, 1) = \{s\},\ \delta(q, 1) = \{r\},\ \delta(r, 0) = \{s\}.$

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Problem 3. Contextfree Grammars.

9+4 Points

The grammar G is defined in the alphabet $\{a, b, c\}$, with the set of variables $\{S, A, B\}$, the start symbol S and by the following rules:

$S \to AB$,
$A \to aA$,
$A \to a$,
$B \to bBc$,
$B \to bc$.

(a) Describe the language $L(G)$ and prove your assertions by induction.

(b) Convert the grammar G in Chomsky normal form.

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Problem 4. Pumping Lemma

7+5 Points

(a) Show, using the Pumping Lemma, that the language

$$L = \{a^i b^j a^k \mid j = \max\{i, k\}, i, j, k \in \mathbf{N}\}$$

is not contextfree.

(b) Prove by giving a counter example that that the following statement is not always true: the infinite union of contextfree languages is also contextfree (In other words: if for each $i \in \mathbf{N}$ the language L_i is contextfree, then $L = \bigcup_{i=0}^{\infty} L_i$ is also contextfree.)

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Problem 5. Decidability

8 Points

Let $A \subseteq \Sigma^*$ and $B \subseteq \Sigma^*$ be semi-decidable. Show that if $A \cap B$ and $A \cup B$ are decidable, then A and B are decidable too.

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Problem 6. Complexity

6 Points

Let $L \in \mathbf{NP}$. Show that if $R \leq_P L$ then $R \in \mathbf{NP}$.

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Paper for notes.