Final term Exam (May 2015) ***Theory of Computation***

Duration : Three Hours ***Dep. : Computer science***

Question NO. 1

a) Given a grammar G={{A,B,S},{a,b},S,P} and P:

S→AB

A→aaA

A→ ε

B→Bb

B→ ε

i. What type of language is this (prove your claim)?

ii. Write an expression for L(G)

iii. Convert this grammar to Chomsky Normal Form

iv. Show the derivation for string "aabbb"

b) Draw a Venn diagram that shows the classification of languages and show where the language L should be located such that:

L={w| w is a palaindrome} (prove your claim)

Question NO. 2

For each of the following languages, mention the most restrictive class to which the language must belong (prove your claim)

a) $L_1 = \{(w, G_1, G_2) \mid G_1, G_2 \text{ are CFGs and } w \in L(G_1) \text{ or } w \in L(G_1)\}$

(TM- Decidable, TM- Recogonizable , not TM- Recogonizable)

b) $L_2 = \{w^2 \mid w \in \{a,b\}^*\}$

(Regualr , Context-free, Decidable)

c) $L_3 = \{w\, w^{R} w \mid w \in \{0,1\}^*\}$ (w^R describes the string w in reverse order)

(Regualr , Context-free, non Context-free)

d) $L_4 = \{1^n 2^m 3^{n+m} \mid where\ n, m \geq 0\}$

(Regualr , Context-free, Decidable)

e) $L_5 = \{w \in \{a,b\}^* \mid w$ contains 2 bs at least$\}$

(Regualr , Context-free, Decidable)

Question NO.3

a) For the language L over the alphabet {a,b} such that:

$L = \{a^{3n} b^n \mid n \geq 0\}$

i. Show whether or not L is a regular language.

ii. Design a Pushdown automaton that accepts L

iii. Design a Turing machine that accepts L

b) According to complexity theory

i. Show the differences between the classes P and NP

ii. Mention the most restrictive class to which S with O (N!) belongs.

iii. What are the benefits from solving S in polynomial time

Question NO. 4

a) $A = \{w \mid w \in \{0,1\}\}$ and w includes a 1 but not as its third character$\}$

i. Give NFA that accepts language A.

ii. Convert NFA to DFA that accepts language A.

iii. Create a regular expression for language A

iv. Represent DFA or NFA for language A in Turing machine

b) For $L = \{a^n b^n a^n b^n \mid where\ n \geq 0\}$

i. Prove that language L is not a context free language.

ii. Design a Turing machine that accepts L

iii. Simulate its action on the input string aabbaabb.

(Best wishes)

Final term Exam (Jan. 2016) | **CS 600**
Duration : Three Hours | **Theory of Computation**
Dr. Assem A. Alsawy | **Dep. : Computer Science**

Question NO. 1 **(20 marks)**

a) Given a grammar G={{A,B,S},{a, b},S,P} and P:

S→AB

A→aaA

A→ ε

B→Bb

B→ ε

1. What type of language is this (prove your claim)?
2. Write an expression for L(G)
3. Convert this grammar to Chomsky Normal Form
4. Show the derivation for string "aabbb"

b) Draw a Venn diagram that shows the classification of languages and show where the language L_1 should be located such that:

$L_1 = \{a^n b^m \mid n \leq m \leq 2n,$ where $n, m \geq 0\}$ (prove your claim)

Question NO. 2 **(15 marks)**

a) A= {w $\in$ {a, b}*: w has 'a' in the 2nd end position from the right}

1. Give DFA that accepts language A
2. Convert DFA to a regular expression for language A

b) For $L = \{a^n b^n a^n b^n | where\ n \geq 0\}$

1. Prove that language L is not a context free language.
2. Design a Turing machine that accepts L
3. Simulate its action on the input string aabbaabb.

Question NO. 3 (20 marks)

For each of the following languages, mention the most restrictive class to which the language must belong (prove your claim)

a) $L_1 = \{a^i b^j c^k d^m \mid i + j + k + m \text{ is multiple of } 13\}$

(Regualr , Context-free, Decidable)

b) $L_2 = \{w^2 \mid w \in \{a,b\}^*\}$

(Regualr , Context-free, Decidable)

c) $L_3 = \{ww^R w \mid w \in \{0,1\}^*\}$ (w^R describes the string w in reverse order)

(Regualr , Context-free, non Context-free)

d) $L_4 = \{1^n 2^m 3^{n+m} \mid where\ n,m \geq 0\}$

(Regualr , Context-free, , non Context-free)

e) $L_5 = \{w \in \{a,b\}^* \mid w$ contains 2 *bs* at least$\}$

(Regualr , Context-free, , non Context-free)

Question NO.4 (20 marks)

a) Consider the following regular expression

$$(0 \mid \varepsilon)(0 \mid 1)^* 0$$

1. Construct an NFA for the regular expression above using Thomson's construction.
2. Convert the NFA to a DFA using the subset construction algorithm
3. Use the algorithm for state minimization to construct a minimized DFA.

b) For the language L over the alphabet {a, b} such that: $L = \{a^{3n} b^n \mid n \geq 0\}$

1. Design a Pushdown automaton that accepts L
2. Design a Turing machine that accepts L

(Best wishes)