CSE331: Automata & Computability
Assignment 1
Total Marks - 20

1. [**5x2 = 10 points**] Write regular expressions of the following languages-
    a. The set of strings that start and end with the same symbols 01. Σ = {0,1,2}
    b. The set of strings that contain both substrings '101' and '000'. Σ = {0,1}
    c. The set of strings having 0 at every 3rd position from the beginning. Σ = {0,1}. For example- 00**0**, 01**0**, 01**0**01**0**0, 11**0**11**0,** etc.
    d. The set of strings that do not contain substring '10'. Σ = {0,1}
    e. The set of strings that do not end with '01'. Σ = {0,1}

2. [**10 Points**] Following is an example of different ways one can declare variables in some programming language.
Write down the regular expression that can generate such variable declarations.
Assume that-
a. All variable names are **at most five (**previously written as **exactly five**; both will be considered correct**)** characters long.
b. Variable names can contain only small letters [a-z], digits [0-9], and two special characters $ (dollar) and _ (underscore).
c. $ sign can only be used at the beginning.
d. No names can start with digits.
e. The variable types are **integer, real, char**, and **Boolean** only.
f. The word 'var' which denotes variable is optional.
g. Ignore any whitespace (space, tab, newline, etc.)
h. Infer the rest of the rules from the code snippets below-

```
var int1 : integer;
var foo_1 : boolean;
var f2 : real;
_ind: char;
x, y, z: integer;
```

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Assignment 2
Total Marks - 20

1. [**4x5 = 20 points**] Construct DFAs for the following languages. Give **both the state diagrams and the state-transition tables**.

a. The set of binary strings that start with "11" and end with "01". Σ = {0,1,2}
b. The set of binary strings which, when converted into an integer number, are divisible by **6**. **The string must not have leading zeros** (for example, 110, 0, and 11110 will be accepted, 0110, 1111, and 101 will be rejected). Empty string (ϵ) will be rejected. (Σ = {0,1}
c. The set of binary strings whose length is odd and has 1 in every even position. (The strings **0** and **1** will also be accepted by the DFA). Σ={0,1}. For example: 0**1**0, 0**11**1, 1**0**1**0**, 1**11**0**1**0**,** etc.
d. The set of binary strings that do not contain exactly two **0**'s. (it may have more than 2 0's, or less). Empty string (ϵ) will be accepted. Σ = {0,1}
e. The set of binary strings with even numbers of **0**'s and with **1**'s in pairs. Σ = {0,1}. For example: ϵ, **11,** 00, **1111**, 0**11**0, **11**0**11**0, 0**11**00**11**0.

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Summer 2021
Assignment 3
Total Marks - 25

1. Draw the NFA from the transition table below and convert it to its equivalent DFA. Show every step clearly. **5**
(Here, → represents Start state and * represents Final state)

State/Σ	0	1	2
→ q0	{q2}	{q1,q3}	{ }
q1	{ }	{q0}	{q0}
q2	{q0}	{ }	{q0}
q3	{q4}	{ }	{q4}
q4*	{ }	{ }	{ }

2. Draw the NFA from the transition table below and convert it to its equivalent DFA. Show every step clearly. **5**

State/Σ	0	1
→ p	{p, q}	{p}
q	{r}	{r}
r	{s}	{ }
s*	{s}	{s}

3. Draw the ε-NFA from the transition table below and convert it to its equivalent DFA. Show every step clearly. **5**

State/Σ	ε	a	b	c
→ p	{ }	{p}	{q}	{r}
q	{p}	{q}	{r}	{ }
r*	{q}	{r}	{ }	{p}

4. Draw the DFA from the transition table below and minimize it using Hopcroft's algorithm. Show every step clearly. **5**

State/Σ	a	b
→ 1*	3	2
2	4	1
3	5	4
4	4	4
5*	3	2

5. Draw the DFA from the transition table below and minimize it using Hopcroft's algorithm. Show every step clearly. **5**

State/Σ	a	b
→ q1*	q3	{ }
q2	q5	q6
q3	q5	q6
q4*	q2	q6
q5	{ }	q1
q6*	q4	{ }

CSE331: Automata & Computability
Assignment 4
Total Marks - 20

Construct Context-Free Grammar for the Following.

1. $a^n b^m c^k d^k e^m f^n$; where n, m, k ≥0. [3 marks]
2. $a^n b^m c^m d^k e^k f^n$; n≥0, m≥1, k≥2. [3 marks]
3. The number of 0s is greater than the number of 1's. [3 marks]
4. $a^m b^n$; m>2n and m,n≥1 [3 marks]
5. a^n b a^m b a^{n+m} ; m,n ≥1 [3 mark]

Left Most Derivation, Right Most Derivation, Ambiguity.

6. S → aSc | X
   X → bXc | ε
   [Here, start variable is S]

   Given the CFG of question 6, answer the following:

a. show Left Most Parse Tree for the String "aaabbccccc" [1 mark]
b. show Right Most Parse Tree for the String "aaabbccccc" [1 mark]

7. S → XY | MN
   X → 0X1 | 01
   Y → 2Y | 2
   M → 0M | 0
   N → 1N2 | 12
   [Here, the start variable is S]

   Given The CFG of Question 7, answer the following:

a. Left Most Derivation of the string "0001112" [0.5 marks]
b. Right Most Derivation of the string "0001112" [0.5 marks]
c. Show that the grammar is ambiguous [2 marks]

CSE331: Automata & Computability
Assignment 5: CNF and CYK
Total Marks - 30

1. **[3*5 = 15 Points]** Consider the given grammars below. Convert each of them to its equivalent Chomsky Normal Form (CNF). State each step clearly.
   a. S → AACD
      A → aAb | ac | **ε**
      C → aC | a
      D → aDa | bDb | d | **ε**

   b. S → XSB | **ε**
      X → pXS | p
      B → SbS | X | bb

   c. S → aAa | bBb | **ε**
      A → C | a
      B → C | b
      C → CD | **ε**
      D → A | B | ab

2. [3*5 = 15 Points] Consider the given grammars below. For each below, find out if the given **CFG** accepts the given string **w** using CYK Algorithm. You must show the triangular table.

a. S → XY |YY
X → ZZ |XY |x
Y → YY |ZX |y
Z → YX |XX |y

String, w: xxyy

b. S → XY |YZ
X → YX |x
Y → ZZ|y
Z → XY |x

String, w: xxyxy

c. $S \rightarrow XY \mid SS \mid a$

$X \rightarrow YS \mid ZT \mid b$

$Y \rightarrow TT \mid b$

$Z \rightarrow TR \mid a \mid b$

$T \rightarrow a$

$R \rightarrow SS$

String, w: abaab