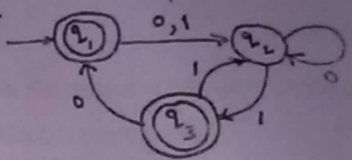
TEST (Theory of Computation) Sept. 26, 2016

Attempt all questions.

Construct a deterministic finite automaton which accepts all strings over $\{a,b\}$ which begin with, or end with, ab. 5

Prove or disprove that the language $\{0^n 1^{2n} : n = 0,1,2,\dots\}$ is regular. 4

Find a suitable regular expression r such that $L(r) = L(M)$, 5
where M is the following finite automaton:



For the regular expression $r = b^* a (a+b)^*$, find a regular grammar G such that $L(r) = L(G)$. 4

If G is a CFG, then show that there exists another CFG $\hat{G}$ such that $L(\hat{G}) = (L(G))^*$ (i.e., the Kleene closure of a CFL is a CFL). 2

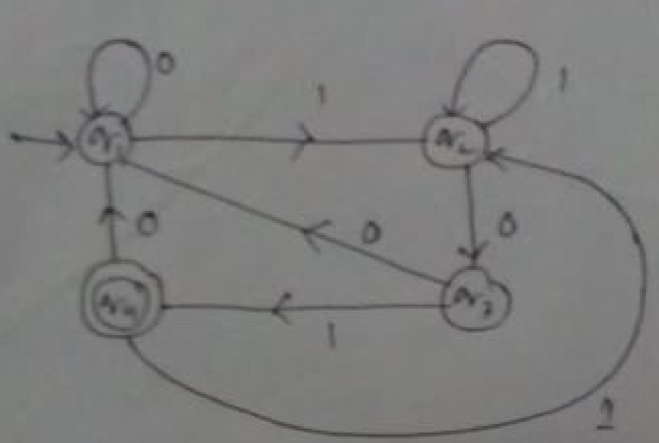
Name –

aSbc

1) Write chomsky classification of languages. (2)

2) construct a grammar G generating $\{a^n b^n c^n \mid n \geq 1\}$ (3)

3) Find the regular expression corresponding to the following Finite automata. (5)



4) show that the language is not regular (3)

$$L = \{ww \mid w \in \{a,b\}^*\}$$

5) Find a reduced grammar equivalent to grammar G which productions are (3)

$$S \rightarrow AB \mid CA$$
$$B \rightarrow BC \mid AB$$
$$A \rightarrow a$$
$$C \rightarrow aB \mid b$$

6) Construct a PDA accepting $\{a^n b^m a^n \mid m,n \geq 1\}$

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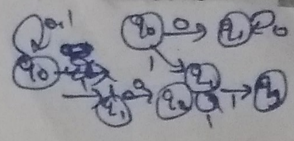


M.Sc. I[st]-Semester Mid-Term Examination 2018

Department of Computer Science, BHU

Paper code: CS207: Theory of Computation

Max. Marks: 20, Time allotted: 1 hr

Answer all questions

1. (a) What is the length of the shortest string NOT in the language L over $\Sigma = \{0, 1\}$ of the regular expression $0^*1^*(10)^*0^*$. [2]

(b) What is the number of states in the minimal DFA corresponding to the regular expression $(0+1)^*(10)$ [2]

(c) Write the regular expression for the language $L=\{w \in (0+1)^* \mid w$ has even number of 1's$\}$. [1]

$(0^*10^*10^*)^*$

2. Design an epsilon NFA for the given language [5]

$L=\{0^p1^q : p+q=odd\}$

convert the epsilon NFA to its equivalent NFA.

3. Construct a Moore machine which can accept set of all strings over {0, 1} and produces output as first letter [3] of your name if ends with '01' and produces output as first letter of your surname if ends with '11', otherwise produces 'η' as output.

[4]

4. (a) Consider the following transition table for a DFA:

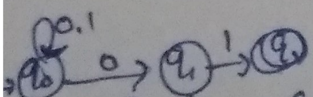
Minimize the DFA using Myhill-Nerode theorem.

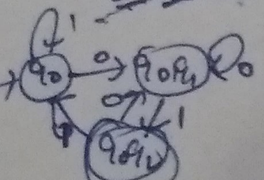
State/Σ	a	b
→ q_0	q_1	q_0
q_1	q_0	q_2
q_2	q_3	q_1
q_3	q_3	q_0
q_4	q_3	q_5
q_5	q_6	q_4
q_6	q_5	q_6
q_7	q_6	q_3

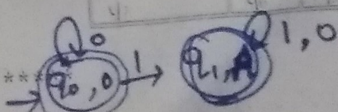
(b) Design a minimum DFA over {0,1} for the following language [3]

$L=\{ w: n_1(w) \bmod 4=3\}$

$0^*10^*10^*10^*(0^*1^*0101^*0^*10^*)^*$







$(0+1)^*$

	0	1
→ q_0	q_0q_1	q_0
q_1	∅	q_2
* q_2	∅	∅

q_0	q_0q_1	q_0
q_0q_1	q_0q_1	q_0q_2
q_0q_2	q_0q_1	q_0

*************END****************

M.Sc. Ist-Semester Examination 2019-20, Department of Computer Science, BHU

Paper code: CS207: Theory of Computation

Time allotted: 1 hour **Note:** *Answer all questions* **Max. Marks: 20**

1 a) What is the length of the shortest string NOT in the language L over Σ = {a,b} of the regular expression b*a*(ab)*b*. 2

b) Explain PDA and NPDA? Which one is more powerful? 2

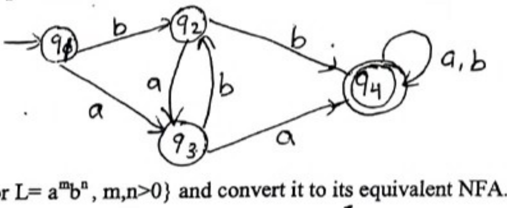
c) Let G=({S,C},{a,b},P,S), where P consists of $S \rightarrow aCa$, $C \rightarrow aCa|b$. Find L(G). 2

d) Define Moore and Mealy machine. Construct a Mealy machine which can count the occurrence of string '10'. 3

2 a) Draw deterministic finite automata over Σ= {a-z}, which can accept a string containing "the" anywhere in a string. e.g., "there" but not "those". 3

b) Define Closure properties of Regular Language. Show that if L1 and L2 are two regular languages then L1 U L2 is also a regular language. 3

3 Find the regular expression corresponding to the automata using Arden's theorem. 3



4 Draw the ε-NFA for L= $a^m b^n$, m,n>0} and convert it to its equivalent NFA. 2

MS/Sem I/309

Roll No. 16411 9CMP026

M.Sc. SEMESTER I EXAMINATION 2016-17

Computer Science

(Rev. Syllabus 2016)

CS-207 : Theory of Compution

Time : Three Hours

Full Marks : 70

(Write your Roll No. at the top immediately on the receipt of this question paper)

Note : Attempt five questions, including questions 1, which is compulsory.

(The figures on the right hand side margin indicate the marks.)

1. (a) Construct a DFA which accepts all strings over $\{0,1\}$, which contain an even number of O's and 1s. 3

(b) Find the language generated by the grammar G, given by : 3
$S \rightarrow ABA,\ A \rightarrow aA \mid bA \mid \wedge,\ B \rightarrow bbb.$
is the language so generated regular?

(c) Construst a PDA which accepts the language which is generated by the CFG given by: 3

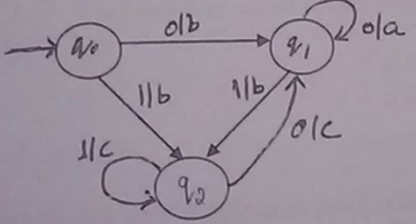
$S \rightarrow Aa \mid Yb, \quad A \rightarrow Sb \mid b, Y \rightarrow Sa \mid a.$

(d) If L is a context-free language over Σ, then show that L^* is also a context- free language over Σ. 3

(e) Define a turning machine and carefully explain the meaning of the language accepted by it. 2

2. (a) State and prove the My hill-Nerode theorem. 5 9

(b) Find a Moore Machine, equivalent to the following Mealy Machine : 5



(c) Show that the language $\{a^p \mid p \text{ is a prime}\}$ is not regular. 4

3. (a) Lat $L = \{a^n b^n c^n \mid n \geq 1\}$. Show that L is precisely the language generated by the grammar G, given by : 7

$S \rightarrow abc \mid SAc,\ cA \rightarrow Ac,\ bA \rightarrow bb.$

(b) Define a PDA and the meanings of the languages accepted by it (i) 'by final state' and (ii) 'by empty stack'. consider a PDA $M = (\{q\}, \{a, b\}, \{z\}, \delta, q, z)$, where $\delta(q, a, z) = \{(q, zz)\}$, $\delta(q, b, z) = \{(q, \wedge)\}$, and which accepts the language L by empty stack. Construct a PDA over $\{a, b\}$, which accepts L by final state. 7

P.T.O.

4. (a) Construct a context – Free grammar which generates a language L, where L is the language accepted by empty stack by the PDA = $(\{q_0, q_1\}, \{0, 1\}, \{x, z_0\}, \delta_0, z_0)$, were δ is given by :

$\delta(q_0, 0, z_0) = \{(q_0, x\,z_0)\}$,

$\delta(q_0, 0, x) = \{(q_0, x\,x)\}$,

$\delta(q_0, 1, x) = \{(q_1, \Lambda)\}$,

$\delta(q_1, 1, x) = \{(q_1, \Lambda)\}$,

$\delta(q_1, \Lambda, x) = \{(q_1, \Lambda)\}$,

$\delta(q_1, \Lambda, z_0) = \{(q_1, \Lambda)\}$.

(b) State and prove the Pumping Lemma for context-fee languages. 7

5 (a) When is a CFG said to be unambiguous? 7

$G = (\{S, T, F\}, \{a, (\,,\,), +, *\}, P, S)$,

Where P consists of the production rules

$S \rightarrow S+T \mid T$

$T \rightarrow T*F \mid F$

$F \rightarrow (S) \mid a$,

is unambiguous.

(b) When is a CFG said to be in chomsky normal form? Transform the grammar G, Given By : 7

$S \rightarrow ab\,AB$

$A \rightarrow b\,AB \mid \Lambda$

$B \rightarrow BA\,a \mid A \mid \Lambda$

6 (a) Give descriptions of Turing machines, 6

(i) Which may not halt on all inputs

and (ii) which 'performs' the operation $\dot{-}$ is defined as :

$$m \dot{-} n = \begin{cases} m - n & \text{if } m \geq n \\ 0 & \text{if } m < n, \end{cases}$$

m, n being two positive integers.

(b) State the church- turing thesis and, assuming it, show that the Halting Problem for Turing machines is undercidable. 8

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MS/Sem I/406

Roll No. ....

M.Sc. SEMESTER I EXAMINATION 2017-18

COMPUTER SCIENCE

CS - 207 : Theory of Computation

Time : Three hours **Max. Marks : 70**

(WRITE YOUR ROLL NO. AT THE TOP IMMEDIATELY ON THE RECEIPT OF THIS QUESTION PAPER)

NOTE : ANSWER ANY FIVE QUESTIONS AND THE FIGURES IN THE RIGHT HAND MARGIN INDICATE MARKS.

Q1 a) Prove the following 6

(i) $\overline{L_d}$ is recursively enumerable but not recursive.

ii) If L is recursive, $\overline{L}$ is also recursive.

iii) Union of two recursive sets is recursive.

b) Given the following statements : 2

(i) Recursive enumerable sets are closed under complementation.

(ii) Recursive sets are closed under complementation.

Which is the correct alternative?

(A) only (i) (B) only (ii) (C) both (i) and (ii) (D) neither (i) nor (ii)

c) Given the following statements : 2

(i) The power of deterministic finite state machine and nondeterministic finite state machine are same.

(ii) The power of deterministic pushdown automaton and nondeterministic pushdown automaton are same.

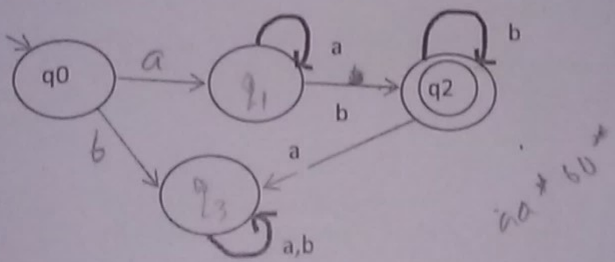
Which of the following is the correct alternative?

(A) Both (i) and (ii) (B) Only (i) (C) Only (ii) (D) Neither (i) nor (ii)

d) What is the language of the following grammar? Explain with proof. 4

N= {S} T= {a,b} P: S-> SaSbS S-> SbSaS S->∈ (ab+ba)*

Q2 a) Convert the following deterministic finite state automaton into its equivalent regular expression. 5

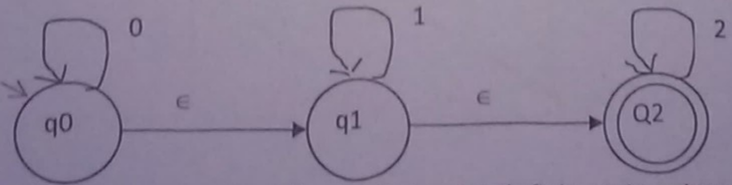


b) Design DFA for the regular expression $(aa+b)^{*}b$. Show each step explicitly. 5

c) When do you say that a language is inherently ambiguous? Give an example of inherently ambiguous language. 4

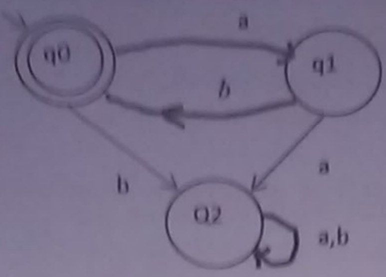
a) Prove that $(r + s)^{*} = (r^{*} s^{*})^{*}$ where r and s are two regular expressions. 5

b) Construct a NFSA without ∈ transition equivalent to the following NFSA with ∈ transition. 5



c) Construct a grammar equivalent to the following Deterministic finite state automaton– 4

P.T.O.



S → ABb | b

Q4

a) Write pumping lemma for regular languages. Show that $L=\{a^n b^n | n \geq 1\}$ is not regular. 4

b) What do you mean by undecidability of a problem? Prove that "ambiguity of CFG" is undecidable. 10

Q5 a) For the following Context Free Grammar, construct push down automata 4

S->aAb, A->ab

b) Reduce the following grammar into Greibach Normal Form. 10

S→ABb | a

A→aaA | B

B→bAb

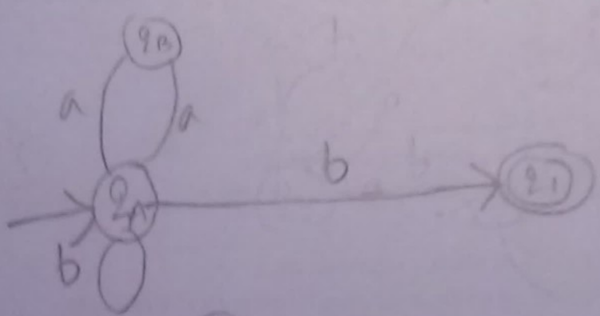
Q6 a) Given the following instance of PCP, does it have a solution? 4

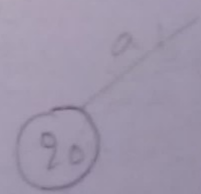
List A	List B
01	0111
1011101	1001
101	01

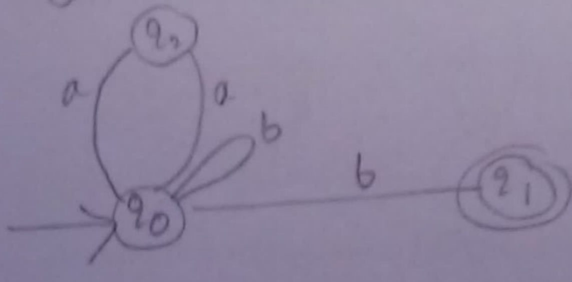
b) Prove the equivalence of deterministic and non-deterministic Turing Machine. 10

------------x------------

$(aa+b)^* b$







Roll no. 8419CMP003

M.Sc. I[st] Semester Examination 2018-19

Computer Science

Paper code: CS207: Theory of Computation

Time allotted: 3 hrs **Max. Marks: 70**

(Write your roll number at the top immediately on the receipt of this question paper)

Note: **Answer any five questions including Q. no. 1**, which is Compulsory.

1. (a) Is it possible for a regular grammar to be ambiguous? [7×2]

(b) Prove that $P+PQ^*Q=a^*bQ^*$, where $P=b+aa^*b$ and Q is any regular expression.

(c) Find a grammar generating $\{\ x^p y^q z^q \mid q>=1,\ p>=0\}$

(d) Write grammar for Context Sensitive languages.

(e) Write the regular expression, representing the set of all strings over {0, 1} having no substring of more than two adjacent 0's .

(f) What are DFAs and NFAs? Which is more powerful?

(g) Write pumping lemma for Context free language. Why is it used?

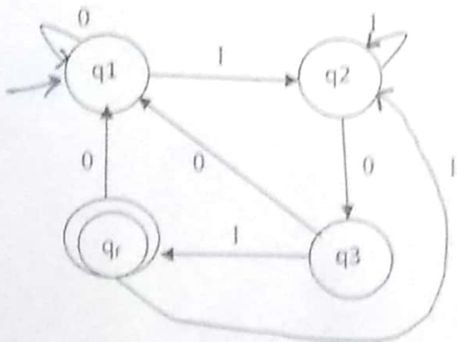
(3+4+4+3)

2. (a) Design a DFA that does not accept any string containing a substring '011' [4+5+5]

(b) Design a minimum DFA over {a,b} for the following language

$L=\{\ w : |w| \bmod 5 = 1\}$

(c) Construct the Regular expression corresponding to the following state diagram



(d) Construct an ε-NFA for the language $L=\{a^n b^m,\ m+n=\text{even}\}$

3. (a) Consider the following productions: [6+8]

$S \to 0B \mid 1A,\quad A \to 0S \mid 1AA \mid 0,\quad B \to 1S \mid 0BB \mid 1$

For the string '0001101110', find

(i) the leftmost derivation,

(ii) the rightmost derivation (iii) the parse tree

Roll no. ....

(b) Give the formal definition of PDA and NPDA. Design a PDA for the language

$$L=\{a^n b^m c^{n+m}, n, m \geq 1\}$$

4. (a) Give the formal definition of standard Turing Machine. Are computers Turing machines? [5+4+5]

(b) What is Church Turing thesis? Explain in brief.

(c) Design a Turing machine that can reverse a given string.

5. (a) Construct the grammar in Chomsky normal form for the following language [5+4+5]

$$\{w\#w^R \mid w \in \{a, b\}^+\}$$

(b) Construct a Mealy machine for 2's complement. Convert it to its equivalent Moore machine.

(c) Define Post Correspondence Problem (PCP). Find at least two solutions to PCP defined by the dominoes:

1	10	10111
111	0	10

6. Write short note on any **four** of the followings: [3.5×4]

(a) The Halting problem

(b) P versus NP problem

(c) Chomsky hierarchy for grammars

(d) Rice's theorem

(e) Equivalence of DFA and NFA

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M.Sc. SEMESTER I EXAMINATION 2019-20

COMPUTER SCIENCE

CS - 207 : Theory of Computation

Time : Three hours | Max. Marks : 70

(WRITE YOUR ROLL NO. AT THE TOP IMMEDIATELY ON THE RECEIPT OF THIS QUESTION PAPER)

Note: ***Answer any five questions including Q. no. 1, which is compulsory.***

1 a. Construct a grammar which generates all even integers up to 998. 4

b. Consider the two regular expressions
$r = a^*+b^*$ and $s = ab^*+ba^*+b^*a+(a^*b)^*$, Find a string corresponding to r but not to s. 2

c. For the Grammar G= ({A, B, S}, {0.1}, P, S), where, P consists of $S \rightarrow 0AB$, $A \rightarrow S0B \mid SB1$, $B \rightarrow 01$. What is L (G)? 2

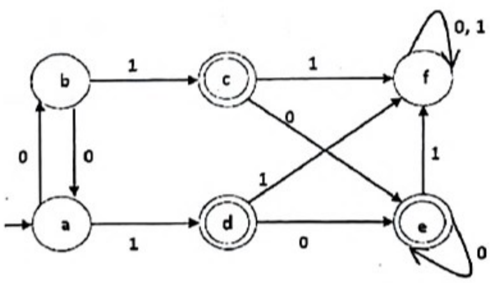
d. Why PDA is more powerful than FA? Explain with an example. 2

e. Describe in English language, the set represented by the following regular expression 2
   i. a^*b+ba^*
   ii. $(aa+b)^*(bb+a)^*$

f. What is halting problem in Turing machine? 2

2 a. Construct a DFA over $\Sigma = \{0,1\}$ accepting the language 4
$L=\{w: |w| \bmod 4=1\}$

b. Consider the following DFA and minimize it using Myphill-Nerode Theorem. 5



c. Are the following true or false? Support your answer by giving proofs or counter examples. 5
   i. If L 1 U L2 is regular and L1 is regular, then L2 is regular.
   ii. If L1 L2 is regular and L1 is regular, then L2 is regular.
   iii. If L* is regular, then L is regular.

3 a. Prove the following identity: 3
$(a^*ab+ba)^*a^*=(a+ab+ba)^*$

b. Construct an ε-NFA for $L=\{a^m b^n, m, n\geq 0\}$, convert it to its equivalent NFA. 4

P.T.O.

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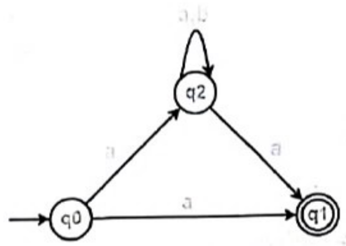
c. Convert the following NFA to its equivalent DFA



d. Construct a Moore machine which prints 'X' whenever '01' is encountered otherwise it will print 'Y'. Convert it to its equivalent Mealy machine. 3

4 a. What are PDA and NPDA? Which one is more powerful? Why stack is used for storage in PDA? Construct a PDA for accepting the language $L=a^m b^m c^n d^n$: m,n≥1 6

b. Show that the grammar S→aB|ab, A→aAB|a, B→ABb|b is ambiguous. 2

c. Reduce the grammar G to Chomsky and Greibach normal form

G=({S}, {0, 1}, {S→SS| 0S1|01}, S) 4

d. Consider the Grammar G=({S, A, B, D}, {a, b}, { S→aS |AB, A→ ε, B→ ε, D→b}, S). Construct a grammar G1 without null productions. 2

5 a. What are Turing machines and its type? What language is accepted by the Turing machine? 5

b. What does computability mean? Explain Church Turing thesis in brief. 4

c. Design a Turing machine that can compute proper subtraction. i.e. X-Y, where X and Y are positive integers. X-Y is defined as X-Y if X > Y and 0 if X≤Y. 5

6 Write short note on any **four** of the followings: 3.5X4

a. The Cook-Levin theorem
b. NP -Hard and NP -Complete Languages
c. Pumping Lemma for Context Free Language.
d. Linear Bounded Automata & Context Sensitive Language
e. Rice's Theorem
f. The Post Correspondence Problem

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