Branch : CSE & IT

Batch : Hinglish

Theory of Computation

Decidability

DPP 01

[MCQ]

1. Consider the following statements?

S_1: For any problem if TM exist then problem may be decidable.

S_2: For any problem if TM not exit then problem may be decidable.

Which of the following is correct?

(a) S_1 only

(b) S_2 Only

(c) Both S_1 and S_2

(d) None of these

[MSQ]

2. Which of the following is / are true about CYK algorithm?

(a) CYK is a bottom up parsing algorithm.

(b) CYK algorithm will take $O(n^3)$ time to verify n – length string.

(c) CYK is a dynamic programing algorithm.

(d) CYK algorithm is used to whether given string is a member of the language or not?

[MCQ]

3. In which of the following machine, halting problem is not decidable?

(a) Finite automata.

(b) Linear bound automata.

(c) Deterministic push down automata.

(d) None of these.

[MCQ]

4. Consider the following Statements:

(i) Non – disjointness problem is decidable for regular expression.

(ii) Totality problem for DPDA is decidable.

(iii) Every decidable problem is also semidecidable.

Which of the following is correct?

(a) (ii) and (iii) only.

(b) (i) and (ii) only.

(c) (iii) only.

(d) All are correct.

[MCQ]

5. Which of the following is decidable to turing machine?

(a) Halting problem.

(b) Blank tape halting problem.

(c) RE membership problem.

(d) None of these.

[MCQ]

6. Consider the following statement:

S_1: In turing machine every final state is dead.

S_2: In turing machine every non – final state may be dead.

Which of the following is correct?

(a) S_1 only

(b) S_2 Only

(c) Both S_1 and S_2

(d) None of these

[MCQ]

7. Which of the following is not correct?

(a) Every semidecidable language is RE.

(b) If language is NOT even semidecidable, then it must be NOT RE.

(c) If language is undecidable then it may be RE.

(d) If a language is semidecidable but not decidable then it may be Recursive.

[MSQ]

8. Which of the following is / are correct?

(a) A language 'L' is semidecidable iff there exist a turing machine which accept 'L'.

(b) A language 'L' is decidable iff there exist a turing machine which accept L and which halts $\forall w \varepsilon \in *$.

(c) A language is decidable iff there exist an algorithm.

(d) None of these.

Answer Key

1. **(c)**
2. **(a, b, c, d)**
3. **(d)**
4. **(d)**
5. **(d)**
6. **(c)**
7. **(d)**
8. **(a, b, c)**

Hint & Solutions

1. (c)

- For any problem TM (RE) exist then problem may be decidable because, for the problem may be HTM exist.
- May be HTM exist: so it may be decidable

Hence, both statements are correct.

2. (a, b, c, d)

- CYK algorithm will tell whether given string is member or not.
- CYK is bottom up parsing algorithm.
- To verify n – length string CYK algorithm will take $O(n^3)$ time. It's also called as dynamic programming.

3. (d)

Halting problem is decidable for FA, DPDA, PDA and LBA (HTM).

4. (d)

- Disjoint ness problem is decidable for DFA / NFA / Regular. $(\text{Disjointness})^C$ = Non – disjointness
- Totality problem for DPDA is decidable.
- Decidable → Recursive

  Semi decidable → Recursive, RE also.

  All decidable are semidecidable.

5. (d)

Halting problem, Blank tape halting problem, state entry problem, post correspondence problem (PCP), modified PCP and RE membership all are undecidable to turing machine.

6. (c)

In turing machine there is no temporary final state like NFA / DFA. TM sees the entire string and check whether it is accepts or reject.

In TM every final state is dead i.e true.

Every non – final state may be dead or may not be dead i.e true.

7. (d)

(a) RE → Semidecidable.

(b) Not RE → Not even semidecidable.

(c) Decidable → Rec

Recursive → RE

(d) Semidecidable but not decidable → RE but not recursive

Hence, option (d) is false.

8. (a, b, c)

All statement are correct.

Branch : CSE & IT Batch : Hinglish

Theory of Computation

Decidability

DPP 02

[MSQ]

1. Let L = {(X) | is a DFA and L (X) is a infinite language }; where (X) represents the illustration of the deterministic finite automata (DFA).

Then which of the statement is/are correct?

(a) It is recognizable by Turing.

(b) Its complement is recognizable by Turing.

(c) It is Turing decidable (recursive).

(d) It is context-free but not regular.

[MSQ]

2. Which of the following statement is/are incorrect?

(a) If L is CFL and A is DCFL then L–A is CFL.

(b) The subset of a decidable language is always decidable.

(c) If L and A are DCFL then $\left(\overline{L} \cap \overline{A}\right)$ is CFL.

(d) None of the above are incorrect.

[MCQ]

3. Consider some language $P \in \{0,1\}^*$ reduces to another language $Q \in \{0,1\}^*$. Which of the following statement is true?

(a) P is decidable.

(b) A Turing machine that recognizes P can be used to construct a truing that recognizes Q.

(c) If Q is decidable then P is decidable.

(d) If P is decidable then Q is decidable.

[MCQ]

4. Consider the following statement:

S_1: In phase structured language, membership problem is semi decidable.

S_2: In context-free languages, membership problem can be solved in ploynomial time.

(a) Only S_1 is true

(b) Only S_2 is true

(c) Both S_1 and S_2 is true

(d) Neither S_1 nor S_2 is true

[MCQ]

5. Consider the following statements:

S_1: For a decidable language X, X^R may or may not be decidable. (X^R represents the reverse of language X).

S_2: If X is not recursively enumerable then $\overline{X}$ must be recursively enumerable.

(a) Only S_1 is true

(b) Only S_2 is true

(c) Both S_1 & S_2 are false

(d) Both S_1 & S_2 are true

[MCQ]

6. Consider the following statements about Turing machine.

S_1: If there is some Turing machine that accepts every string in L and rejects every string not in L then L is decidable.

S_2: If there is some Turing machine that accepts every string in L and either rejects or loops on every string not in L, then L is semi-decidable or computably enumerable (CE).

(a) Only S_1 is true

(b) Only S_2 is true

(c) Both S_1 & S_2 are true

(d) Neither S_1 nor S_2 is true

[MSQ]

7. Which of the following is/are decidable properties of context-free?

(a) for context-free grammar X, find if string $w \in X$.

(b) for context-free grammar X, find if $L(X) = \phi$.

(c) for context-free grammar X, find if L(X) is infinite.

(d) none of the above are decidable properties of context free.

[MCQ]

8. Consider the following statements:

S_1: There is language for which no TM available. Then surely language will be Not RE.

S_2: Language is undecidable if and only there is no HTM available for language.

Which of the following is incorrect?

(a) S_1 only.

(b) S_2 only.

(c) Both S_1 and S_2.

(d) Neither S_1 Nor S_2.

Answer Key

1. **(a, b, c)**
2. **(a, b, c)**
3. **(c)**
4. **(c)**
5. **(c)**
6. **(c)**
7. **(a, b, c)**
8. **(d)**

Hint & Solutions

1. (a, b, c)

L → regular

(a) True: Regular ⊂ recursively enumerable.

(b) True: $\overline{\text{regular}}$ = regular and regular ⊂ RE.

(c) True: regular ⊂ recursive.

2. (a, b, c)

(a) False: CFL is not closed under intersection.

(b) False: Σ* is decidable but it has undecidable subsets (a^p → P is not prime)

(c) False: same as option a

Hence, a, b, c are false

3. (c)

If P is reduced to Q then properties of Q are possessed by P hence, answer is 'C'.

4. (c)

S_1: True → membership problem in unrestrited (∴ Phrase is unerstricted) is semi- decidable

S_2: True → using CYK algorithm, membership problem in context-free language can be solved in ploynomial time.

5. (c)

S_1: False → On input 'P', the algorithm for X^R, will reverse 'P' and then run the algorithm for X.

S_2: False → There are langauge like REGULAR which are not R.E. and their complement is also not RE.

6. (c)

- If there is some Turing machine that accepts every string in L and rejects every string not in 'L' then 'L' is decidable.
- If there is some Turing machine that accepts every string in L and either rejects or loops on every string not in L then L is semi decidable or computably enumerable(CE).

7. (a, b, c)

- There exists a membership algorithm for CFG so, it is decidable.
- Context-free emptiness problem is decidable.
- The context-free finiteness problem is decidable.

8. (d)

Both statements are correct.

So, Correct option is (d).

Branch : CSE & IT **Batch : Hinglish**

Theory of Computation

Finite Automata

DPP-01

[MCQ]

1. Consider decimal alphabet $\Sigma = \{0, 1, 2, ...9\}$, then how many two length strings are possible?

(a) 4 (b) 20

(c) 100 (d) 2

[MCQ]

2. Consider a binary alphabet $(\Sigma) = \{0, 1\}$

How many 3 length strings are possible, the third symbol of the string must be 0?

(a) 4 (b) 8

(c) 3 (d) 5

[MSQ]

3. Consider the following strings and their respective lengths:

$|w_1| = p$

$|w_2| = q$

$|w_3| = r$

Then, which of the following is/ are correct?

(a) The length of the string $w_1 \cdot w_2 = pq$

(b) The length of the string $w_1 \cdot w_2 \cdot w_3 = p + q + r$

(c) The length of the string $w_1 \cdot w_2 \cdot w_3 = pqr$

(d) The length of the string $w_1 \cdot w_3 = p + r$

[MCQ]

4. Which of the following is correct about Regular Grammar?

(a) Every Regular grammar is Left Linear Grammar.

(b) Every Right Linear grammar may/may not be Regular Grammar.

(c) If grammar is regular then it must be left linear as well as right linear.

(d) If grammar is regular then it must be left linear or right linear.

[MSQ]

5. Which of the following is / are not an alphabet?

(a) $\Sigma = \{a, b, ab\}$

(b) $\Sigma = \{1, 2, 3, 4 ....\}$

(c) $\Sigma = \{ \}$

(d) $\Sigma = \{\in\}$

[MSQ]

6. If w is a string and w^R is reversal of the string then which of the following is incorrect?

(a) $\left(w^R\right)^R = w$

(b) $\left(ww^R\right)^R = w \cdot w^R$

(c) $\left(wxw^R\right)^R = w \cdot x \cdot w^R$

(d) $\left(ww^R\right)^R = w^R \cdot w$

[NAT]

7. For 10 length strings, Total number of maximum substrings possible are _____.

[NAT]

8. Consider following statements:

S_1: Every prefix or suffix is a substring.

S_2: Total number of prefixes are same as total number of suffixes in a string.

S_3: Total number of suffixes for n length string is (n + 1).

Number of correct statements are _____.

Answer Key

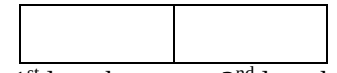
1. **(c)**
2. **(a)**
3. **(b, d)**
4. **(d)**
5. **(a, b, c)**
6. **(b, c, d)**
7. **(56)**
8. **(3)**

Hints and solutions

1. (c)

Alphabet (Σ) = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}

- Zero length string = 1 i.e., {∈}
- One Length strings = 10
  {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}
- Two Length Strings = 100



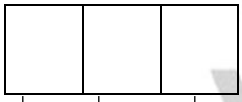
1st length 2nd length

[0 - 9] [0 - 9]

10 * 10 = 100

2. (a)

- Alphabet (Σ) = {0, 1}
- 3rd symbol of the string must be 0 means last symbol fix. i.e., 0
-



1st length 2nd length 3rd length

(0, 1) (0, 1) * (0)

= 2 * 2 * 1 = 4

Strings = {010, 000, 100, 110}

Hence, option (a) is correct.

3. (b, d)

$|w_1| = p$

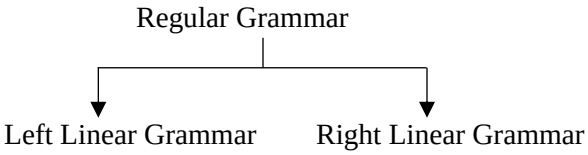
$|w_2| = q$

$|w_3| = r$

- $|w_1 \cdot w_2 \cdot w_3| = p + q + r$
- $|w_1 \cdot w_2| = p + q$
- $|w_1 \cdot w_3| = p + r$

Hence, option (b, d) are correct.

4. (d)



- Grammar is regular if and only if either its LLG or RLG
- Right Linear Grammar: $V \rightarrow TV^*|T^*$
- Left Linear Grammar: $V \rightarrow VT^*|T^*$

5. (a, b, c)

- Alphabet is a set of finite non-empty symbol.
- Symbols in alphabet must be atomic.

(a) Σ = {a, b, ab}
part of the symbol not allowed.

(b) Σ = {1, 2, 3, ...}
Set of infinite symbols not allowed.

(c) Σ = { } empty not allowed.

(d) Σ = {∈} Allowed because in place of empty string we can put λ.

6. (b, c, d)

Let w = abc

Then w^R = cba

(a) $\left(w^R\right)^R = (cba)^R = abc = w$ **True**

(b) $\left(w \cdot w^R\right)^R = (abc.cba)^R = abccba$

False

(c) $\left(w\ x\ w^R\right)^R = abc\ x^R\ cba$

False

(d) $\left(ww^R\right)^R \neq w^R \cdot w$ **False**

Hence, option (b, c, d) is correct

7. **(56)**

Range [56 to 56]

- for n length string, maximum number of substrings are $\frac{n(n+1)}{2}+1$
- for 10 length string, number of substrings = $\frac{10*11}{2}+1=56$

8. **(3)**

String (w) = 100

Prefix = {∈, 1, 10, 100} = 4

Suffix = {∈, 0, 00, 100} = 4

(1) **True:** Every prefix or suffix is a consecutive subpart of string.

(2) **True:** Number of prefixes = Number of suffixes.

(3) **True:** For n length string (n + 1) are prefix or suffix.

Branch : CSE & IT | Batch : Hinglish

Theory of Computation
Regular Expression Part-1

DPP-02

[MSQ]

1. Which of the following is/are true?

(a) $(a^*b^*)^* = (b^*a^*)^*$

(b) $(a + \in)^+ = a^+$

(c) $(a + b)^* (ba)^* = (ab)^* (a + b)^*$

(d) $(ab + ba)^* = (ab(ab)^* + ba(ba)^*)^*$

[MCQ]

2. Consider the following regular expressions:

(I) $a^* b^* + a^*$

(II) $(\in + aa^*) (bb^* + \in)$

(III) $b^*a^* + a^*b^* + b^*$

(IV) $aa^+ bb^+$

Which the following is equivalent to a^*b^*?

(a) (I) and (II) only

(b) (I) only

(c) (II) and (III) only

(d) (I) and (IV) only

[MCQ]

3. Which of the following is not correct?

(a) $a^* bb^* = a^* b^+$

(b) $a^* a^+ = a^+$

(c) $a^+a^+ = a^+$

(d) $\phi^* = \in$

[MSQ]

4. Regular expression can be used in:

(a) Lexical Analysis

(b) Pattern matching

(c) String matching

(d) Syntax analysis

[MCQ]

5. Consider the regular expression:

regular expression = $a^*b(a + ba^*)^*$

Above regular expression is equivalent to which of the following below regular expression?

(a) $ba^*(bb)^*$

(b) $ba^*(a + ba^*b)^*$

(c) $(b + aa^*b) + (b + aa^*b) (ba^*b + a) (ba^*b + a)^*$

(d) $a^*b (a + b)^*$

[MCQ]

6. Which of the following statement will generate finite language?

(a) PDA with finite stack.

(b) Regular expression without kleene star and kleene plus.

(c) Regular expression with unary alphabet.

(d) Regular expression with binary alphabet.

[MCQ]

7. Consider following regular expressions:

[I] $(ab)^*a = a(ab)^*$

[II] $(bb)^*b^* = b^*$

[III] $(b + \in)^+ = b^*$

Which of the following is correct?

(a) II and III only.

(b) I and II only.

(c) All are correct.

(d) None of these are correct.

[NAT]

8. Consider the string $\left[(ab)^{10}(ab)^7\left((ab)^3\right)^2\right]^2$,

the length of the string is ____.

Answer Key

1. **(a, c, d)**
2. **(a)**
3. **(c)**
4. **(a, b)**
5. **(d)**
6. **(b)**
7. **(a)**
8. **(46)**

Hints and Solutions

1. (a, c, d)

(a) $(a^*b^*)^* = \{\in, a, b, \ldots\}^*$
$= (a + b)^*$
$(b^*a^*) = \{\in, a, b, \ldots\}^*$
$= (a + b)^*$ True

(b) $(a + \in)^+ = a^+ + \in$
$= a^*$ False

(c) $(a + b)^* (ba)^* = (a + b)^* \in$
$= (a + b)^*$
It will generate all the strings on alphabet {a, b}
$(ab)^* (a + b)^* = \in(a + b)^*$
$= (a + b)^*$ True

(d) $\{(ab) (ab)^* + (ba) (ba)^*\}^*$
$= (ab + ba)^*$ True

2. (a)

Regular expression = a^*b^*
$a^* = \in + aa^*$
$b^* = \in + bb^*$

- $a^*b^* + a^* = a^*b^*$
- $a^*b^* + a^* = (\in + aa^*) (bb^* + \in)$

Hence, (a) is correct.

3. (c)

(a) $a^*bb^* = a^*b^+$ Correct
Because $r\, r^* = r^+$

(b) $a^*a^+ = a^+$ Correct
$r^*r^+ = r^+ = r\, r^*$ All are equal

(c) $a^+a^+ = aa^*aa^*$ Incorrect
$= (aa)a^*$

(d) $\phi^* = \in$ Correct

* contain minimum string $\in$.

4. (a, b)

Regular expression can be used in pattern matching, lexical analysis, text editing etc.

5. (d)

$a^*b\,(a + ba^*)^*$
Put $a^* = \in$
$a^*b\,(a + b)^*$

6. (b)

- PDA with finite stack is same as DFA, and DFA can generate finite and infinite language.
- Regular expression without kleene star(*) always generate finite language.

Note: Kleene plus(+) is an expansion of kleene star(*).

- a^* = infinite
- $(0 + 1)^*$ = infinite

7. (a)

- $(ab)^*a = a(ab)^*$ **False**
- $(bb)^*\, b^* = \{\in, b, bb, bbb, bbbb \ldots.\}$
$= b^*$ **True**
- $(b + \in)^+ = (b^+ + \in) = b^*$ **True**

8. (46)

$$= \left[(ab)^{10}(ab)^7\left((ab)^3\right)^2\right]^2$$

$$= \left((ab)^{17}(ab)^6\right)^2$$

$$= (ab)^{46}$$

Length of the string = 46.

Branch : CSE/IT Batch : Hinglish

Theory of Computation
Finite Automata

DPP-03

[MCQ]

1. For $L = \{a^n b^m \mid n,m \geq 0\}$
What will be the regular expression ?
(a) $(a^* b^*)^*$ (b) $a^* b^*$
(c) $(ab)^*$ (d) $b^* a^*$

[MCQ]

2. Consider the following regular expressions:
(I) $(aa + aaa)^* = aa^+$
(II) $(a^*b\ (a + b)^* + (a^*b^*)^*) = (a + b)^*$
(III) $(\varepsilon + aaa\ (aaa)^*)\ (\varepsilon + a + aa) = (a + aa + aaa)^*$
Which the following is correct?
(a) (I) and (III) only.
(b) (II) and (III) only.
(c) All are correct.
(d) None of them are correct.

[MSQ]

3. Which of the following is/are regular expression for the language:
L = { containing ab as a substring}
(a) $b^* aa^*b\ (a^*b^*)^*$
(b) $(a + b)^*\ (ab)^*\ (a + b)^*$
(c) $(a^*\ b^*)^*\ ab\ (a^* + b^*)^*$
(d) $(a + b)^*\ ab\ (a + b)^*$

[MCQ]

4. What will be the regular expression for $L = \{a^{2n} \mid n \geq 15\}$ over $\sum = \{a\}$
(a) $a^{15}(aa)^*$
(b) $(aa)^* a^{15}$
(c) $a^{30}\ (aa)^*$
(d) None of these

MCQ]

5. Which of the following string does not belong to $(ab^*)^*$?
(a) aaabbaa (b) baaaabb
(c) aaabbb (d) ababa

Answer Key

1. **(b)**
2. **(b)**
3. **(a, c, d)**
4. **(c)**
5. **(b)**

Hints and solutions

1. (b)

Regular expression for L = $\{a^n b^m | n,m \geq 0\}$ = a*b*

2. (b)

False: $(aa + aaa)^*$ = (aa)*

True: (a*b (a + b)* + (a*b*)*) = (a + b)*

True: (ε + aaa (aaa)*) (ε + a + aa) = (a + aa + aaa)*

3. (a, c, d)

- b* aa*b (a*b*)* will generate all the strings which content ab as substring.
- (a* b*)* ab (a* + b*)* will generate all the strings which content ab as substring.
- (a + b)* ab (a + b)* will generate all the strings which content ab as substring.

4. (c)

Regular expression for L = $\{a^{2n} | n \geq 15\}$ = (aa)* a^{30} = a^{30} (aa)*

5. (b)

baaaabb is not present in (ab*)*.

Branch : CSE/IT Batch : Hinglish

Theory of Computation

Finite Automata

DPP-04

[MCQ]

1. Consider following two statements:

S_1: Every DFA can be converted into equivalent NFA

S_2: NFA design is easy because NFA help us to write a program.

Which of the following is correct?

(a) S_1 only.
(b) S_2 only.
(c) Both S_1 and S_2 are correct.
(d) Both are incorrect.

[MSQ]

2. Which of the following statements is/are correct about finite automaton?

(a) Finite automata represent only finite language.
(b) Finite automata represents only infinite language.
(c) Transition function in NFA is $Q \times \sum | \cup \{\in\} = 2^Q$
(d) Every regular language is finite.

[MCQ]

3. From each state, how many transition are possible in DFA for each input symbol?

(a) Exactly 1 (b) At least 1
(c) Exactly 2 (d) Al least 2

[MCQ]

4. Consider following two statements:

S_1: If every state is final state in DFA, then L(DFA) = $\sum^*$

S_2: If every state is non-final state in DFA, then L(DFA) = $\{\in\}$

(a) S_1 only.
(b) S_2 only.
(c) Both S_1 and S_2 are correct.
(d) Both are incorrect.

[MCQ]

5. For L = $\{(a + b)^2\}$, how many states are required in minimal DFA?

(a) 2 (b) 3
(c) 4 (d) 1

Answer Key

1. **(a)**
2. **(c)**
3. **(a)**
4. **(a)**
5. **(c)**

Hints and solutions

1. (a)

- Every DFA can be converted into equivalent and Vice versa.
- DFA help us to write a program.

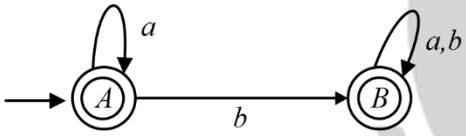
2. (c)

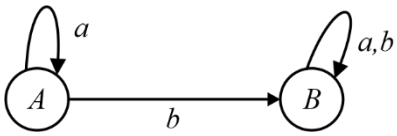
- Finite automata represents regualr set, regular set can be finite or infinite.
- Transition function in NFA is $Q \times \sum | \cup \{\in\} = 2^Q$
- Regular language can be finite or infinite.

3. (a)

From each state, exactly one transition is possible in the DFA for each input symbol.

4. (a)

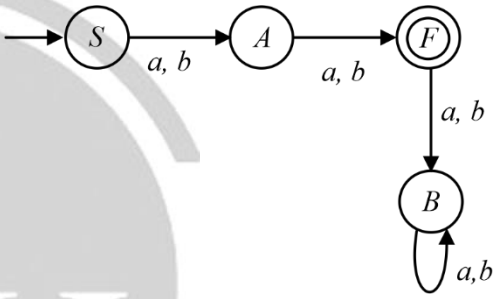
- 

- $L(DFA) = \sum^* = (a+b)^*$
- 

$L(DFA) = \phi = \{\ \}$

Hence, only statement (1) is correct.

5. (c)



Number of states = 4.

Branch : CSE/IT Batch : Hinglish

Theory of Computation

Finite Automata

DPP-05

[MCQ]

1. Design deterministic finite automata of set of all binary strings over Σ = {0,1}, where every binary string starting with 00100. How many minimum numbers of states required for above FA?

(a) 6 (b) 5

(c) 7 (d) 4

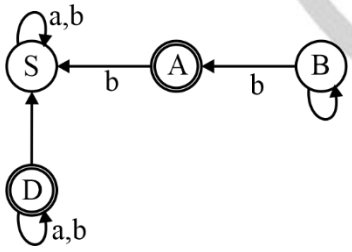
[NAT]

2. How many states are required to design a minimal DFA for set of all binary strings over Σ = {0, 1} where every binary string containing '0110' as a substring? ____ .

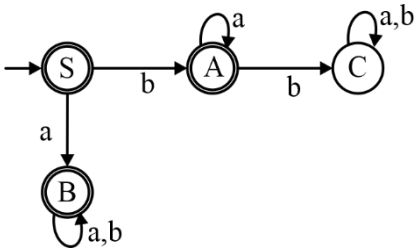
[MCQ]

3. Which of the following is correct design of a minimal DFA for set of all strings over Σ = {a, b} where every string does not start with bb?

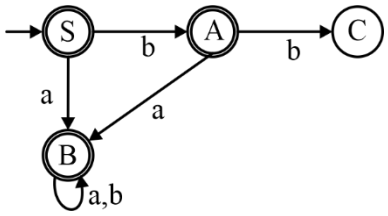
(a)



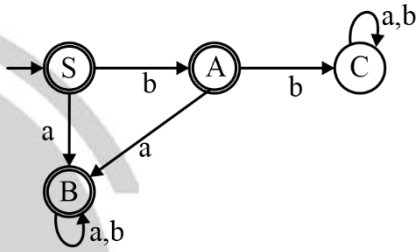
(b)



(c)



(d)



[MSQ]

4. Which of the following statement is/are correct?

(a) DFA is possible for every regular language

(b) DFA is also possible for some non-regular languages.

(c) DFA is possible for both finite language and regular infinite language.

(d) There exist only 1 unique DFA for every regular language.

[NAT]

5. How many states required to design a minimal DFA for L = {X ba | X ∈ {a, b} *}? _____

[NAT]

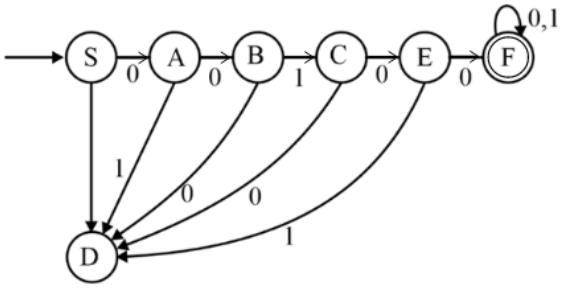
6. Number of final states required to design a minimal DFA for L = {$(\in + b + a)^2$ | Σ = {a, b}} is / are _____.

Answer Key

1. **(c)**
2. **(5)**
3. **(d)**
4. **(a, c, d)**
5. **(3)**
6. **(6)**

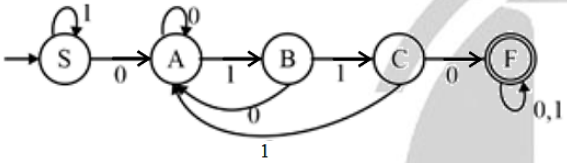
Hints and solutions

1. (c)



Number of states = 7.

2. (5)

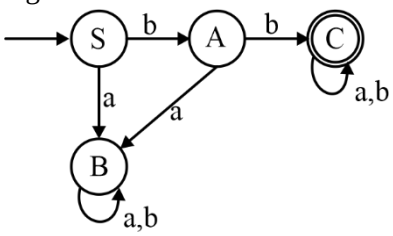


Number of States = 5.

3. (d)

- Every string does not start with bb is a complement of the language of starting with ab.
- To design complement of the DFA make non-final states and final. Final states make non-final.

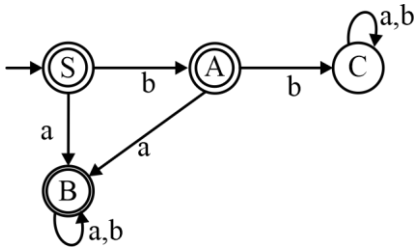
starting with bb:



Final states = {C}

Non final states = {S, A, B}

⇓ complement of above DFA



Final states = {S, A, B}

Non final states = {C}

Hence, option (d) is correct.

4. (a, c, d)

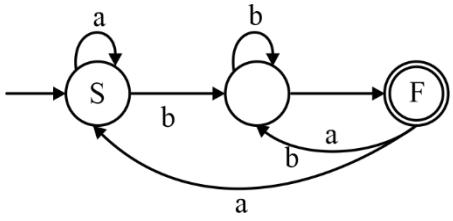
- If language is regular, there exist 1 unique DFA (Minimal DFA).
- If language is non-regular, DFA design not Possible.
- Regular language can be finite or infinite.
- Minimal DFA (Unique DFA) possible for every regular language.

Hence, statement (a, c, d) are correct.

5. (3)

L = {Xba | X ∈ {a, b} *}

L = set of all strings where every string ends with 'ba'.



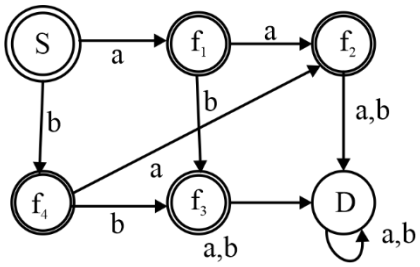
Number of states = 3

6. (6)

L = {(∈ + a + b)^2}

L = {∈, aa, ab, ba, bb, a, b}

Minimal DFA Design:



Branch : CSE & IT | Batch:Hinglish

Theory of Computation

Finite Automata

DPP-06

[NAT]

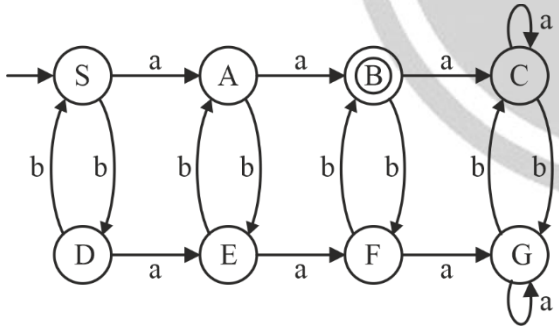
1. Let L be the set of all binary strings whose last three symbols are the same. The number of states in the minimum state DFA accepting L is ___.

[MCQ]

2. Consider a language L over Σ = {b}, L= {w | $n_a(w)$ multiple of 2 but not multiple of 4}.
How many states are required to design a minimum state DFA for above language L?
(a) 6 (b) 8
(c) 4 (d) 5

[MCQ]

3. The following finite state machine accept all those strings in which the number of a's and b's are respectively



(a) Divisible by 2 and even.
(b) Equal to 2 and odd.
(c) Equal to 3 and even.
(d) Equal to 2 and even.

[MCQ]

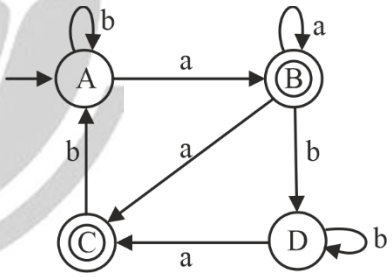
4. Consider the following given language L on alphabet Σ = {a, b}.
L = {w | w ∈ {a, b}*, 2nd symbol is 'a' OR 4th symbol of w is 'b'}.
How many states are required to design a minimal DFA for L?
(a) 6 (b) 7
(c) 5 (d) None of these

[MCQ]

5. Which one of the following language over the alphabet {a, b} is described by the regular expression:
$(a + b)^*a(a + b)^*a(a^*b^*)^*a\ (a + b)^*$?
(a) The set of all the strings containing the substring 000.
(b) The set of all the strings that begin and end with same alphabet.
(c) The set of all strings containing almost three a's.
(d) The set of all strings containing at least three a's.

[MCQ]

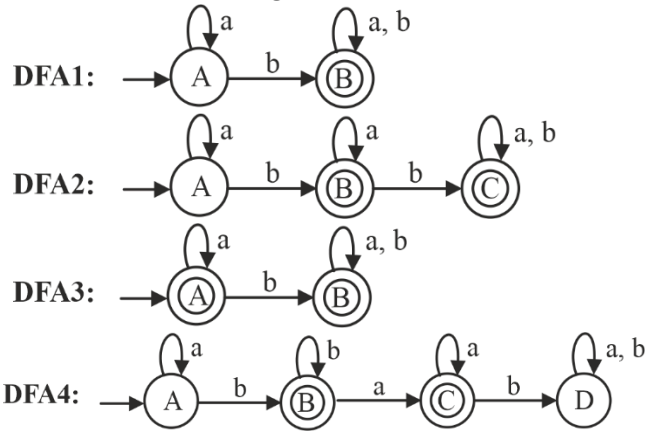
6. Identify the language accepted by the following deterministic finite automata over the input alphabet Σ = {a, b}.



(a) All strings of a's and b's.
(b) All strings which are ending with a.
(c) All strings which do not end with b.
(d) All strings which contain 'a' as the substring.

[MCQ]

7. Consider the following DFA's.



Which of the above DFA's are equivalent?

(a) DFA1 and DFA2
(b) DFA2 and DFA3
(c) DFA3 and DFA4
(d) None of these

[MCQ]

8. Consider the following regular expression (RE)
RE = $(a+b)^*(a+b+\varepsilon)a$

Which of the following is equivalent to the above RE?

(a) $(a^* + b^*) + (aa + ba)$
(b) $(\varepsilon + a + b^*)^+ a$
(c) $(a + b) + (a + b + \varepsilon)a$
(d) None of these

Answer Key

1. **(7)**
2. **(c)**
3. **(d)**
4. **(a)**
5. **(d)**
6. **(b)**
7. **(a)**
8. **(b)**

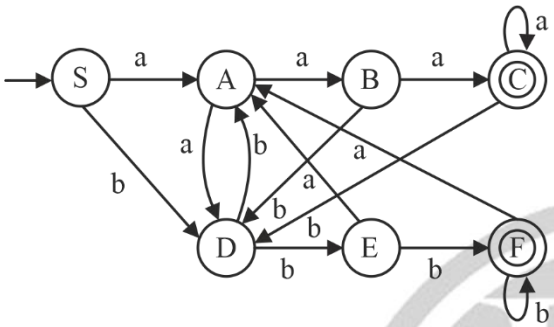
Hints and Solutions

1. (7)

$\Sigma = \{0, 1\}$

L = {aaa, bbb, abbb, bbbb, baaa, aaaa, …}

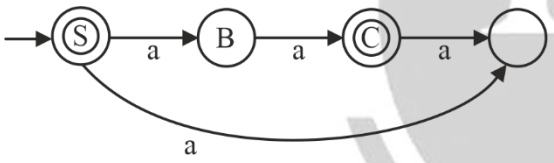
MDFA:



2. (c)

MDFA:

L = {∈, a^2, a^6, a^{10}, a^{14}, …}



Number of states = 4

3. (d)

It will accept number of a's in the language must be 2 and number of b's in the language must be even.

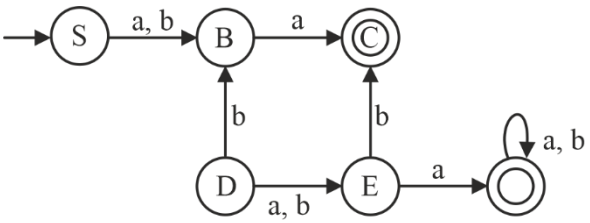
Regular expression = $(bb)^*a(bb)^*a(bb)^*$

Note: Given DFA is not minimized DFA

4. (a)

$L = \left\{ \overline{a|b}\ \overline{a}\ \overline{a|b}\ \overline{a|b}\ \overline{a|b}\ b - - - \right\}$ OR $L = \left\{ \overline{a|b}\ \overline{a|b}\ \overline{a|b}\ \overline{a|b}\ b - - - \right\}$

MDFA:



Number of states = 6

5. (d)

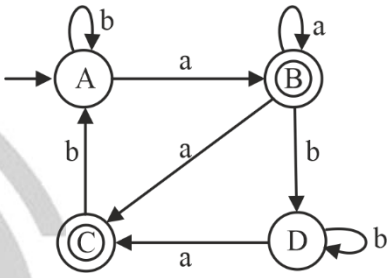
Regular expression: $(a + b)^*a(a + b)^*a(a + b)^*a(a + b)^*(a^* + b^*) = (a + b)^*$

Strings = {aaa, aaaa, $b^*ab^*ab^*ab^*ab^*$….}

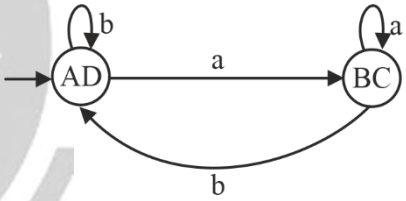
L = {atleast 3a's}

Hence, option (d) is correct

6. (b)



is equivalent to



The given DFA accepts the language of all strings where every string ends with a.

7. (a)

DFA1 and DFA2 are equivalent. Both accepts the same language that has all strings contain b.

$[RE = (a + b)^*b(a + b)^*] = a^*b(a + b)^*$.

DFA3 accepts the universal language: (a+b)*.

DFA4 accepts a*bb*a*.

8. (b)

$RE = (a + b)^*(a + b + \varepsilon)a = (a + b)^*a$

$(\varepsilon + a + b^*)^+ a = (a + b)^* a$

∴ Option (b) is equivalent to given RE.

Branch : CSE & IT | Batch:Hinglish

Theory of Computation
Finite Automata

DPP-07

[MCQ]

1. Let $L_1 = \phi$, $L_2 = \{\varepsilon\}$, $L_3 = \{a,\varepsilon\}$.
L_1, L_2, L_3 are languages defined over $\Sigma = \{a\}$
then, $L_3.L_2.L_1^* + L_1.L_3$ is_____ .

(a) ϕ (b) $\{a\}$
(c) $\{a, \varepsilon\}$ (d) $\{a^n \mid n \geq 2\}$

[MCQ]

2. Consider the following given grammar
$S \rightarrow AB$
$A \rightarrow AS \mid a$
$B \rightarrow BA \mid SB \mid b$
Which of the following string generated by above grammar?

(a) bbaa (b) baba
(c) aabb (d) baab

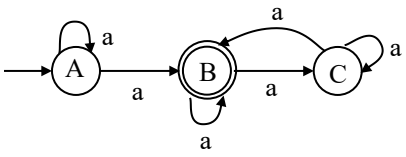
[MCQ]

3. If the finite automaton M has 100 states and all the states are Non final except initial state over the alphabet $\Sigma = \{0, 1\}$ then the set L(M) can be:

(a) ϕ
(b) Σ^*
(c) $\{\varepsilon\}$
(d) Subset of Σ^*

[MCQ]

4. Consider the following finite automata.



Find the language accepted by above FA.

(a) a* (b) aa*
(c) aaa* (d) a(aa)*

[MCQ]

5. Which of the following language does not satisfy the prefix property?

(a) $L = \{a^n b^n \mid n \geq 1\}$
(b) $L = \{wxw^R \mid w \in (0+1)^*\}$
(c) $L = \{a^m b^{2m} \mid m \geq 1\}$
(d) $L = \{w \in (0+1)^* \mid n_0(w) = n_1(w)\}$

[MCQ]

6. Consider the following left linear Grammar.
$S \rightarrow Sa|Sb|A$
$A \rightarrow Aab|\varepsilon$
Choose the correct language generated by the above grammar.

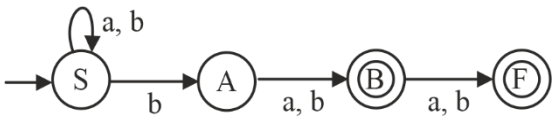
(a) $(a+b)^*$ (b) $(a+b)^+$
(c) $(a+b)^* ab$ (d) $(a+b)^+ ab$

[NAT]

7. Consider a language $L = \{w \mid w \in \{a, b\}^*, 5^{th}$ symbol from end is 'a'$\}$
If number of state in NFA is P and Number of states in MDFA (minimal DFA) is Q then the value of P * Q is _____.

[MCQ]

8. Consider the following finite automaton:



Which one of the following is correct representation of above finite automaton?

(a) Second symbol from ends is 'b'.
(b) Containing (b + ab + ba) as a substring.
(c) Third symbol from ends is 'b'
(d) None of these.

Answer Key

1. **(c)**
2. **(c)**
3. **(d)**
4. **(b)**
5. **(d)**
6. **(a)**
7. **(192)**
8. **(c)**

Hints and Solutions

1. (c)

$L_1 = \phi \Rightarrow L_1^* = \varepsilon$

$L_2 = \varepsilon \Rightarrow L_2 = \varepsilon$

$L_3 = \{a, \varepsilon\}$

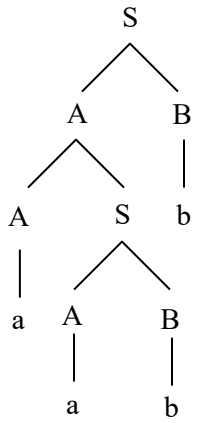
$L_3.L_2.L_1^* + L_1.L_3 = L_3.\varepsilon.\varepsilon + \varphi.L_3$

$= L_3 + \varphi$

$= L_3$

$= \{a, \varepsilon\}$

2. (c)



S always generates the strings starting with a so, option (a), (b), (d) is not possible.

3. (d)

M is a DFA with 100 states only initial state in final and all other states Non final.

So, language is defined only at initial state and it can be part of Σ^*.

$\therefore L(M) \subseteq \Sigma^*$.

4. (b)

$L = \{a, aa, aaa, \ldots\}$

$= a^+$

Given FA accepts a^+.

5. (d)

$L = \{w \in (0 + 1)^* \mid n_0(w) = n_1(w)\}$

Let $x, y \in L$

$x = 10, y = 1010$

x is a proper prefix of y. If it is possible to find two different strings in L such that one is proper prefix of other, then L has no prefix property.

6. (a)

$S \rightarrow Sa|Sb|A$

$A \rightarrow Aab|\varepsilon$

It can generate all strings when A is substituted with null production.

$S \rightarrow Sa|Sb|\varepsilon$ is enough to generate $(a + b)^*$.

7. (192)

$L = \{w \mid w \in \{a, b\}^*, n^{th}$ symbol from ends is a$\}$

NFA = n + 1 states

MDFA = 2^n states

$P * Q = (5 + 1) * (25)$

$= 6 * 32$

$= 192$

Hence, (192) is correct answer.

8. (c)

Regular expression of FA

Regular expression = $(a + b)^* b (a + b)^2$

This RE represents third symbol from ends must be b.

Hence, option (c) is correct.

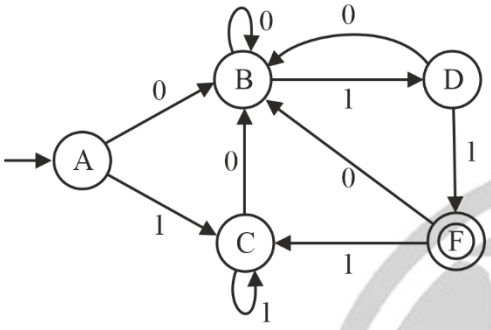
Branch : CSE & IT Batch:Hinglish

Theory of Computation
Finite Automata

DPP-08

[MCQ]

1. Consider the following DFA over Σ ={0, 1}



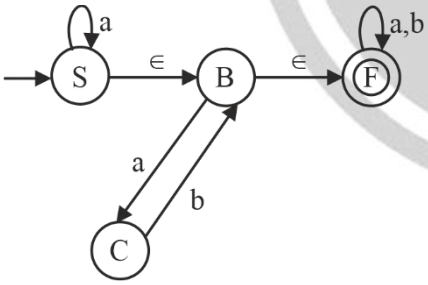
How many states are required in minimal DFA?

(a) 3 (b) 2

(c) 4 (d) 5

[MCQ]

2. Consider the following epsilon NFA:



What is the set of reachable states for the input string ba?

(a) {B, F}

(b) {F}

(c) {C, B, F}

(d) {S, B, F}

[MCQ]

3. For language (L) = {Xw |X = {ab}, w = {a, b}*}

How many states are required in NFA for above language (L)?

(a) 4

(b) 3

(c) 6

(d) None

[MSQ]

4. Which of the following statement is/are correct?

(a) Every DFA can be converted into equivalent NFA.

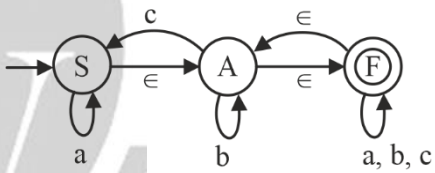
(b) Every DFA can be convert into equivalent ∈-NFA.

(c) Every NFA can be converted into equivalent minimal DFA.

(d) NFA with ∈-moves is not equivalent to NFA without epsilon move.

[MSQ]

5. Consider the following ∈-NFA:



Which of the following is/are correct regular expression for above ∈-NFA?

(a) $a^*b^*(a + b)^*$

(b) $(a + b + c)^*$

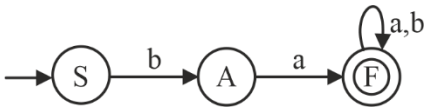
(c) $a^*b^+c^+(a + b + c)^*$

(d) $a^*b^*c^*(c + a + b)^*$

[MCQ]

6. Consider the following finite state automaton (M)

M:



Let $\overline{M}$ be the modified automaton obtained from M by interchanging finals and non-finals. If language accepted by above automaton is L(M), then the language accepted by $L(\overline{M})$ will be:

(a) $L(\overline{M}) = \{a(a + b)^*, (bb)(a + b)^*, \in\}$

(b) $L(\overline{M}) = \{\in, b\}$

(c) $L(\overline{M}) = \{\text{not starting with 'ba'}\}$

(d) $L(\overline{M}) = \text{none of these}$

[NAT]

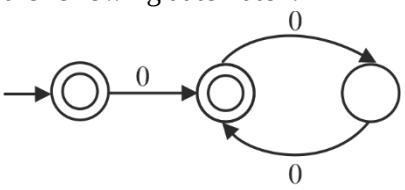
7. Given a language L, define L′ as follows:

$L^0 = \{\in\}$

$L^i = L^{i-1}. \forall_{i>0}$

The order of a language L is defined as the smallest k such that $L^k = L^{k+1}$.

Consider the language L_1 (over alphabet 0) accepted by the following automaton.



The order of L_1 is _____.

Answer Key

1. **(c)**
2. **(b)**
3. **(b)**
4. **(a, b, c)**
5. **(b, d)**
6. **(b)**
7. **(2)**

Hints and Solutions

1. (c)

0 equivalent:

{A, B, C, D} {F}

Non-final states Final state

1 equivalent:

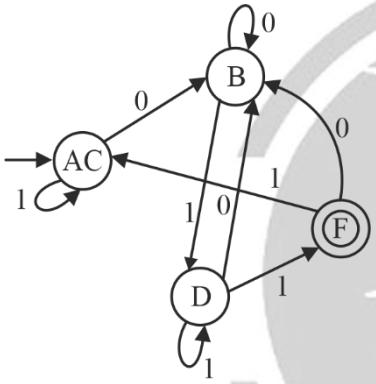
{A, C} {B} {D} {F}

2 equivalent:

{A, C} {B} {D} {F}

Number of states = 4

Minimized DFA



2. (b)

$\delta^*(S, ba) = \{F\}$

Hence, option (b) is correct.

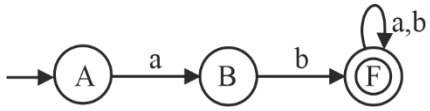
3. (b)

$L = \{Xw \mid X = \{ab\}, w = \{a, b\}^*\}$

$L = ab(a + b)^*$

= {start with ab}

NFA =



Number of states = 3

4. (a, b, c)

DFA ≅ NFA ∈ ≅-NFA

Hence, option (a, b, c) are correct.

5. (b,d)

$L = \{\in, a^*, b^* c^*, (a + b + c)^* \ldots\}$ L

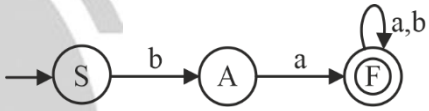
$= (a + b + c)^*$

$a^*b^*(a + b + c) = \in \cdot \in (a + b + c)^*$

$= (a + b + c)^*$ Hence, option (b, d) are correct.

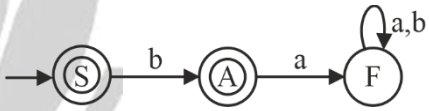
6. (b)

M:



$L(M) = ba(a + b)^*$

$\bar{M}$:



$L(\bar{M}) = \{b, \in\}$

Hence, option (b) is correct.

7. (2)

Smallest value of k = 2

Any issue with DPP, please report by clicking here:- https://forms.gle/t2SzQVvQcs638c4r5

For more questions, kindly visit the library section: Link for web: https://smart.link/sdfez8ejd80if

PW Mobile APP: https://smart.link/7wwosivoicgd4

Branch : CSE & IT Batch:Hinglish

Theory of Computation
Finite Automata

DPP-09

[MSQ]

1. Which of the following is/are correct?

(a) Transition function (δ) in mealy machine and moore machine is same.

(b) Output function (λ) in moore machine is $\lambda: Q \rightarrow \Delta$.

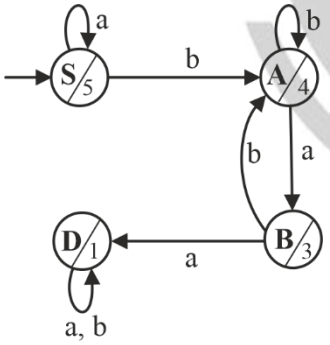
(c) Output function (λ) in mealy machine is $\lambda: Q \times \Sigma \rightarrow \Delta$.

(d) Output is associated with state in mealy machine.

[NAT]

2. Consider the following moore machine:

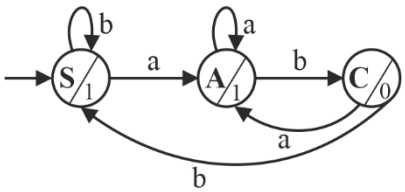
Moore machine:



On input "abbabb" the output will be___.

[MCQ]

3. Consider the following moore machine:



The above moore machine will produce

(a) 0 output for every occurrence of bab.

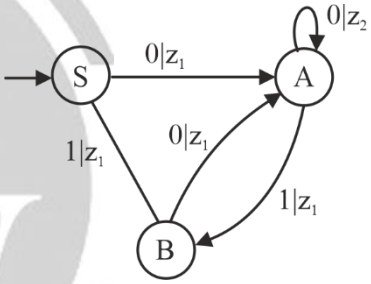
(b) 1 output for every occurrence of aa.

(c) 0 output for ever occurrence of ab.

(d) None of these.

[MCQ]

4. Consider the following mealy machine on $\Sigma = \{0, 1\}$



For input "010100" what will be the output?

(a) $z_1z_1z_1z_1z_1z_2$.

(b) $z_1z_2z_1z_2z_1z_2$.

(c) $z_1z_2z_1z_2z_1z_2$.

(d) None of these.

[MCQ]

5. Consider the following statements:

S_1: Mealy machine and moore machine both are equivalent.

S_2: For n length input moore machine produces (n + 1) length output.

Which of the following is correct?

(a) S_1 only.

(b) S_2 only.

(c) Both S_1 and S_2 are correct.

(d) None of these.

Answer Key

1. **(a, b, c)**
2. **(5544344)**
3. **(c)**
4. **(a)**
5. **(c)**

Hints and Solutions

1. (a, b, c)

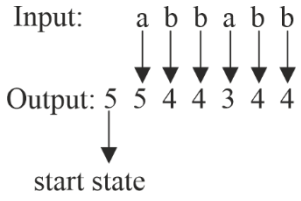
(a) True: $\delta: Q \times \Sigma \rightarrow Q$ Moore machine
$\delta: Q \times \Sigma \rightarrow Q$ Mealy machine

(b) True: $\lambda: Q \rightarrow \Delta$ Moore machine

(c) True: $\lambda: Q \times \Sigma \rightarrow \Delta$ Mealy machine

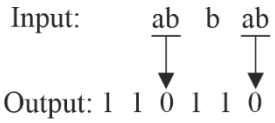
(d) False: In moore machine output is associated with state.
In mealy machine output is associated with transition.

2. (5544344)



Hence, (5544344) is correct.

3. (c)



Hence, option (c) is correct.

4. (a)

Input: 0 1 0 1 0 0
Ouput: z_1 z_1 z_1 z_1 z_1 z_1

5. (c)

S_1: Both are equivalent.
S_2: Moore machine generates 1 extra output.

Branch : CSE & IT Batch:Hinglish

Theory of Computation
Finite Automata

DPP-10

[MCQ]

1. Consider alphabet $\sum = \{a, b\}$, the empty string $\in$ and the set of strings S, P, Q and R generated by the corresponding non-terminals of a regular grammar. S, P, Q and R related as follows (S is a start symbol):

$S \rightarrow aP \mid bQ \mid \in$

$P \rightarrow bR \mid aS$

$Q \rightarrow aR \mid bS$

$R \rightarrow aQ \mid bP$

(a) $L = \{w: n_a(w)$ and $n_b(w)$ both are even$\}$.
(b) $L = \{w: n_a(w)$ and $n_b(w)$ both are odd$\}$.
(c) $L = \{w: n_a(w)$ or $n_b(w)$ are even$\}$.
(d) None of these.

[MSQ]

2. Consider the following language L on alphabet $\sum = \{a, b\}$

$L = \{wxw^R \mid w, x \in \{a, b\}^+\}$

The correct regular grammar of above language is/are possible?

(a) $S \rightarrow aAa \mid bAb$
$A \rightarrow aA \mid bA \mid a \mid b$
$B \rightarrow aA \mid bA \mid a \mid b$

(b) $S \rightarrow aAa \mid bAb \mid \in$
$A \rightarrow ab$

(c) $S \rightarrow aA \mid bB$
$A \rightarrow aA \mid bA \mid a$
$B \rightarrow bB \mid aB \mid b$

(d) $S \rightarrow Aa \mid Bb$
$A \rightarrow Aa \mid Ab \mid a$
$B \rightarrow Bb \mid Ba \mid b$

[MCQ]

3. Consider the following statements:

S_1: If language is regular then, grammar must be regular.

S_2: If grammar is regular then, language can't be regular.

Which of the following is correct?

(a) S_1 is true.
(b) S_2 is true.
(c) Both S_1 and S_2 are true.
(d) None of these

[MCQ]

4. Consider the following grammar G:

G:

$S \rightarrow A\ B\ C$
$A \rightarrow aA \mid a$
$B \rightarrow bc$
$C \rightarrow cC \mid \in$

The language generated by above grammar is?

(a) $L = \{a^*\ bc\ c^*\}$
(b) $L = \{a^+\ b\ c^+\}$
(c) $L = \{a^*\ b\ c^*\}$
(d) None of these

[NAT]

5. For language $\{a^*bb^*a^+b^* \cup b\ a^*b\}$ the minimum pumping length will be ____.

[NAT]

6. Consider some regular expression:

r_1: $a^*bb^*c^*(ab)^*$

r_2: $a^*b^*\ ab \cup (bb)^*$

If minimum pumping length of r_1 is P_1 and minimum pumping of r_2 is P_2 then the value of $P_1 * P_2$ will be ____.

[MCQ]

7. Suppose, a language L has finite automata M with N states. The language generated by FA is L(M) is an infinite if and only if $\exists_w \in L$ such that

(a) $N \geq |w| \leq 2N$
(b) $N \leq |w| \leq 2N-1$
(c) $N \leq |w| \geq 2N-1$
(d) None of these

[MCQ]

8. Consider the following grammars G_1 and G_2:

G_1: $S \rightarrow aS \mid S \mid A$

$A \rightarrow aA \mid abA \mid \in$

G_2: $S \rightarrow aS \mid a$

Which of the following grammar is/are regular?

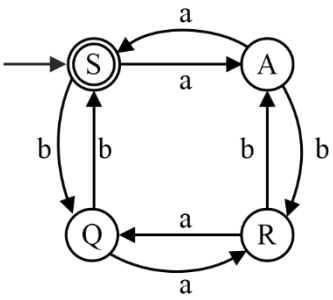
(a) G_1 only
(b) G_2 only
(c) Both G_1 only G_2
(d) None of these

Answer Key

1. **(a)**
2. **(c, d)**
3. **(d)**
4. **(b)**
5. **(3)**
6. **(6)**
7. **(b)**
8. **(c)**

Hints and Solutions

1. (a)



$L = (aa + ab + ba + bb)^*$

Hence, option (a) is correct.

2. (c, d)

$L = \{wxw^R \mid w, x \in \{a, b\}^+\}$

$a(a + b)^+ a \mid b(a + b)^+ b$

$\downarrow$ $\downarrow$

$ab(a + b)^+ba$ $ba(a + b)^+ba$

$aa(a + b)^+aa$ $bb(a + b)^+ bb$

L = Regular

Regular expression = $a(a + b)^+ a + b(a + b)^+b$

(a) False: Given grammar is not regular.

(b) False: Given grammar is not regular.

(c) True: $a(a + b)^+a + b(a + b)^+b$ RLRG

(d) True: $a(a + b)^+a + b(a + b)^+ b$ LLRG

Hence, (c, d) are correct.

3. (d)

- False: Grammar may/may not be regular.
- False: If grammar is regular, then language must be regular.

4. (b)

$S \rightarrow ABC = aa^*bcc^*$

$A \rightarrow aA \mid a = aa^*$

$B \rightarrow bc = bc$

$C \rightarrow cC \mid \in = c^*$

Regular expression = aa^*bcc^*

$= a^+ bc^+$

Hence, option (b) is correct.

5. (3)

$L = \{a^*bb^*a^+b^* \cup ba^* b\}$

Minimal string (w) = ba, bb

Pumping length = |w| + 1

= 2 + 1

= 3

6. (6)

$r_1 = a^*bb^*c^*(ab)^*$

$p_1 = 2$

$r_2 = a^*b^*ab \cup (bb)^*$

$p_2 = 3$

$p_1 * p_2 = 6$

7. (b)

$N \le |w| \le 2N–1$

Option (b) is correct.

8. (c)

G_1: $S \rightarrow aS \mid S \mid A$

$A \rightarrow aA \mid abA \mid \in$

Regular grammar

Regular grammar

- $V \rightarrow T^*V \mid T^*$ RLRG
- $V \rightarrow VT^* \mid T^*$ LLRG

G_2: $S \rightarrow aS \mid a$

Regular grammar.

Branch : CSE & IT | Batch:Hinglish

Theory of Computation

Finite Automata

DPP-11

[MSQ]

1. Which of the following language is/are regular?

(a) $L = \{a^m b^n\} \mid m \not< n \text{ and } m \not> n\}$

(b) $L = \{a^n b^n c^n \mid n \geq 100\}$

(c) $L = \{a^m b^n \mid LCM\ (m, n) = 100\}$

(d) $L = \{aaa^n b^n bb \mid n \geq 1\}$

[MCQ]

2. Consider the following two language L_1 and L_2.

$L_1 = \{www \mid w \in \{a\}^*\}$

$L_2 = \left\{\{a^{n^n}\}^* \middle| n \geq 1\right\}$

Which of the following is correct?

(a) L_1 is regular.

(b) L_2 is regular.

(c) Both L_1 and L_2 are regular.

(d) None of these.

[MCQ]

3. Which of the following language is non-regular?

(a) $L = \{wxw^R \mid x, w \in \{a, b\}^*\}$.

(b) $L = \{wxw \mid w, x \in \{a, b\}^*\}$.

(c) $L = \{wxwx \mid w, x \in \{a, b\}^+\}$.

(d) None of these

[MCQ]

4. Consider the following grammar G_1 and G_2:

G_1: $S \to aAb$

$A \to aB \mid \in$

$B \to Ab$

G_2: $S \to aABb$

$A \to aA \mid \in$

$B \to bB \mid \in$

Which of the following grammar generates a regular language?

(a) G_1 only (b) G_2 only

(c) Both G_1 and G_2 (d) None of these

[NAT]

5. Consider the following three languages:

(1) $L = \left\{a^{n^n} \middle| n \geq 1\right\}$

(2) $L = \left\{a^{m^n} \middle| m = n^2, n \geq 1\right\}$

(3) $L = \left\{a^{m^n} \middle| n \geq 1, m > n\right\}$

Total number of regular languages is/are_____.

[MCQ]

6. Consider the following grammar

G:

$G = S \to AB \mid CD$

$A \to aaA \mid \in$

$B \to bB \mid \in$

$C \to aaC \mid \in$

$D \to bD \mid \in$

The language generated by above grammar is:

(a) Finite (b) Infinite but regular

(c) Non-regular (d) None of these

[MCQ]

7. Which of the following language is non-regular?

(a) $L = \{a^{2m} b^n b^n \mid m, n \geq 1\}$

(b) $L = \{a^m b^n X \mid m, n \geq 1, X \in \{a,b\}^*\}$

(c) $L = \left\{\{a^{n^2}\}^* \middle| n \geq 0\right\}$

(d) None of these

Answer Key

1. **(a)**
2. **(c)**
3. **(d)**
4. **(b)**
5. **(1)**
6. **(b)**
7. **(d)**

Hints and Solutions

1. (a)

(a) $L = \{a^m b^n \mid m \not< n \text{ and } m \not> n\}$

$L = \{a^m b^n \mid m = n\}$

= not regular

(b) $L = \{a^m b^n c^n \mid n \geq 100\}$

Not regular

(c) $L = \{a^m b^n \mid LCM(m, n) = 100\}$

Finite $\rightarrow$ Regular

(d) $L = \{aaa^n b^m bb \mid m, n \geq 1\}$

$L = aa(a)^n bb(b)^n$

Not regular

Hence, option (c) is correct.

2. (c)

$L_1 = \{wxw \mid w \in \{a\}^*\}$

$L_1 = (aaa)^*$

Regular language

$L_2 = \left\{\left\{a^{n^n}\right\}^* \middle| n \geq 1\right\}$

$L_2 = \{a^1\}^*$

$= a^*$

= Regular.

3. (d)

(a) $L = \{wxw^R \mid x, w \in \{a, b\}^*\}$

Minimal string $= \in \cdot (a + b)^* \in$

$= (a + b)^*$

Regular

(b) $L = \{wx\, w \mid w, x\ \{a, b\}^*\}$

$L = \in \cdot (a + b)^* \cdot \in$

$= (a + b)^*$

Regular

(c) $L = \{wxwx \mid w, x \in \{a, b\}^+\}$

Minimal string $= a(a + b)^+ a\ (a + b)^+$ **or**

$b(a + b)^+ b\ (a + b)^+$

$ab\ (a + b)^+ ab\ (a + b)^+$ cover by minimal string

$ba\ (a + b)^+ ba\ (a + b)^+$ cover by minimal string

$aa\ (a + b)^+ aa\ (a + b)^+$ cover by minimal string

$bb\ (a + b)^+ bb\ (a + b)^+$ cover by minimal string

Regular

Hence option (d) is correct.

4. (b)

G_1: $S \rightarrow aAb$

$A \rightarrow aB \mid \in$

$B \rightarrow Ab$

$L = a\ A\ b$

$= ab$

$L = a\ A\ b$

$= a\ a\ B\ b$

$= a\ a\ A\ b\ b$

$= a\ a\ a\ B\ b\ b$

$= a\ a\ a\ A\ b\ b\ b$

$= a\ a\ a\ b\ b\ b$

Number of a's equal to number of b's. Comparision not possible in DFA(regular).

G_2: $S \rightarrow aABb$

$A \rightarrow aA \mid \in = a^*$

$B \rightarrow bB \mid \in = b^*$

$L = aa^*\ b^*b$

= Regular

G_2 is regular

Hence option (b) is correct.

5. (1)

(1) $L = \left\{a^{n^n} \middle| n \geq 1\right\}$

$L = \{a, a^4, a^{27}, \ldots.\}$ Non-regular

(2) $L = \left\{a^{m^n} \middle| m = n^2, n \geq 1\right\}$

$L = \left\{a^{1^1}, a^{4^2}, a^{9^3} \ldots.\right\}$

$= \left\{a, a^{16}, a^{43} \ldots.\right\}$

Non-regular

(3) $L = \left\{a^{m^n} \middle| n \geq 1, m > n\right\}$

$L = \left\{a^{2^1}, a^{3^1}, a^{4^1} \ldots.\right\}$

$= \left\{a^2, a^3, a^4 \ldots.\right\}$

$= aa(a)^*$

Regular

6. (b)

$S \rightarrow AB \mid CD = (aa)^*b^* + (aa)^*b^*$

$A \rightarrow aaA \mid \in = (aa)^*$

$B \rightarrow bB \mid \in = (b)^*$

$C \rightarrow aaC \mid \in = (aa)^*$

$D \rightarrow bD \mid \in = b^*$

L = Regular (infinite regular)

Hence, option (b) is correct.

7. (d)

(a) $L = \{a^{2m} b^n b^n \mid m, n \geq 1\}$

$= (aa)^+ b^{2n}$

$= (aa)^+ (bb)^+$ Regular

(b) $L = \{a^m b^n X \mid X \in \{a, b\}^* m, n \geq 1\}$

$= (a)^+ (b)^+ (a + b)^*$

= Regular

(c) $L = \left\{\left\{a^{n^2}\right\}^* \middle| n \geq 0\right\}$

$L = \{\in, a, aa, aaa \ldots\}$

$= a^*$

= Regular

Hence, option (d) is correct.

Branch : CSE & IT Batch:Hinglish

Theory of Computation

Finite Automata

DPP-12

[MCQ]

1. Which of the following language is not regular?

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

(b) $L = \{xy \mid x, y \in \{a, b\}^*\}$

(c) $L = \{xy \mid |x| = |y| \; x, y \in \{a, b\}^*\}$

(d) None of these

[MSQ]

2. Which of the following language is/are regular?

(a) $L = \{ww^R \mid w \in \{0, 1\}^*\}$.

(b) L = {Set of all palindrome}.

(c) L = {Number of a's equal to number of b's}.

(d) $L = \{wwp \mid w, p \in \{0, 1\}^*\}$

[MCQ]

3. Consider the following given language L.

$L = \{p\ q\ w\ w\ y\ r \mid w, p, q, r \in \{a, b\}^*\}$

The regular expression generated by above language is?

(a) $(a + b)^2\ (aa + bb)\ (a + b)$

(b) $[(a + b)^2]^*\ (aa + bb)\ (a + b)^*$

(c) $(a + b)^*$

(d) None of these

[MCQ]

4. Consider the language $L = \{w\ w\ p \mid w, p \in \{a , b\}^+\}$

Which of the following regular expression generated by above language?

(a) $(a + b)^+$

(b) $(a + b)^+\ (a + b)^+$

(c) $(aa + bb)\ (a + b)^+$

(d) None of these

[NAT]

5. Consider the following language L:

$L = \{xw \mid\mid x \mid = 2, w \in \{a, b\}^*\}$

For the above language L, how many equivalence classes are possible?_____.

[MCQ]

6. Consider the following languages.

$L_1 = \{w\ x\ w^R\} \mid w, x \in \{a, b\}^+\}$

$L_2 = \{w\ w^R\ x \mid w, x \in \{a, b\}^+\}$

Which of the following language is regular?

(a) L_1 is regular.

(b) L_2 is regular.

(c) Both L_1 and L_2 are regular.

(d) None of these.

Answer Key

1. **(d)**
2. **(d)**
3. **(c)**
4. **(d)**
5. **(3)**
6. **(a)**

Hints and Solutions

1. (d)

(a) Regular = (a + b)*

(b) Regular = (a + b)* (a + b)*
= (a + b)* Regular

(c) L = {xy | |x| = |y| x, y ∈ {a, b}*}
L = {aa, ab, ba, bb, bbaa, bbab …}
L = All even length string = Regular.

Hence, option (d) is correct.

2. (d)

L = {wwp | w,p ∈{0, 1}*}
L = ∈.∈. p = (0 + 1)*
= Regular

3. (c)

L = {pqwwr | p,q,r, w∈{a, b}*}
L = pq ∈∈r
= pqr
= (a + b)* (a + b)* (a + b)*
= (a + b)*

Hence, option (c) is correct.

4. (d)

L = {wwp | w, p ∈ {a, b}$^+$}
= minimal string = aap, bbp

- aaaap ∈ aap
- ababp ∉ any minimal string
- babap ∉ any minimal string
- bbbbp ∈ bbp

so, regular expression not possible.

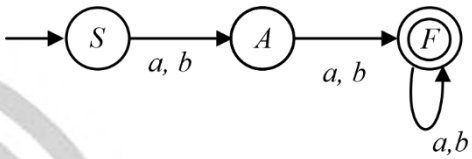
Hence, option (d) is correct.

5. (3)

L = {xw ||x| = 2, w ∈ {a, b}*}

Regular expression = $(a + b)^2 (a + b)^*$

DFA:

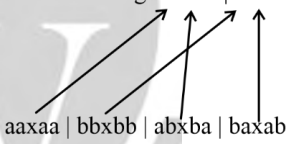


Number of equivalence classes = 3

6. (a)

L1 = {wxw^R | w, x }∈{a, b}$^+$}

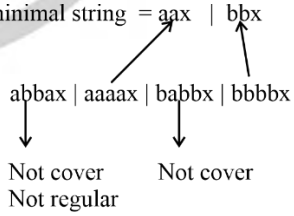
minimal string = a x a | b x b



L1 is regular.

L_2 = {ww^{R}x | w, x ∈ {a, b}$^+$}

minimal string = aax | bbx



Hence, option (a) is correct

Branch : CSE & IT Batch : Hinglish

Theory of Computation
Chapter : Finite Automata

DPP 13

[MCQ]

1. Consider the following statements:

S_1: Kleene Closure (*) of infinite set is always finite.

S_2: Kleene Closure (*) of finite set is always infinite.

Which of the following is correct?

(a) S_1 only.
(b) S_2 only.
(c) Both S_1 and S_2 are correct.
(d) None of these.

[MCQ]

2. Consider a language L, then subset of L will be?

(a) Regular.
(b) Regular but finite.
(c) Non-regular.
(d) None of these.

[MSQ]

3. Consider two languages L_1 and L_2.

$L_1 = a^*b^*$

$L_2 = b^*a^*$

Which of the following is/are correct for above languages.

(a) $L_1 \cup L_2$ is regular.
(b) For $L_1 \cup L_2$ regular expression will be $(a + b)^*$.
(c) $L_1 \cap L_2$ is regular.
(d) For $L_1 \cap L_2$ regular expression will be $(a^* + b^*)$.

[MCQ]

4. If subset of L_1 is regular then what is L1?

(a) L_1 must be finite.
(b) L_1 must be regular.
(c) L_1 must be non-regular.
(d) None of these.

[MCQ]

5. Regular language does not close under on which operation?

(a) Complement
(b) Union
(c) Subset
(d) Intersection.

[NAT]

6. Consider the following statements:

[I] If L is regular, then $\overline{L}$ is regular.
[II] If $\overline{L}$ is regular, then L is regular.
[III] Union of L and its complement is Σ^*.

Number of correct statement is/are_____.

[MSQ]

7. Let $L_1 = \{\in\}$

$L_2 = \{a^+\}$

Then which of the following is correct?

(a) $L_1 \cap L_2 = \in$.
(b) $L_1 \cup L_2$ = any language.
(c) $L_1 \cup \overline{L}_2 = \in$.
(d) None of these.

Answer Key

1. **(d)**
2. **(d)**
3. **(a, c, d)**
4. **(d)**
5. **(c)**
6. **(3)**
7. **(b, c)**

Hints & Solutions

1. (d)

S_1: False

Set = $\{\in\} = \{\in\}^* = \in$ only (Finite)

S_2: Set = $\{a\} = \{a\}^* = \in, a, aa, aaa, .. = (a^*)$ (Infinite)

So, both statements are false.

Hence, option (d) is correct.

2. (d)

Let, Language (L) = $(a + b)^*$

- $a^n b^n$ is a subset of $(a + b)^*$
  but $a^n b^n$ is not a regular and also not finite.
- ab is a subset of L bit ab is a finite and regular.

Hence, option (d) is correct.

3. (a, c, d)

$L_1 = a^* b^*$ (Regular)

$L_2 = b^* a^*$ (Regular)

- $L_1 \cup L_2 = a^* b^* + b^* a^*$
- Union is closed under regular.
  $L_1 \cup L_2$ = regular
- $L_1 \cap L_2 = a^* b^* \cap b^* a^* = a^* + b^*$
- Intersection closed under intersection
  $L_1 \cap L_2$ = Regular $\cap$ Regular = Regular

Hence, options (a, c, d) are correct.

4. (d)

If subset of L_1 is regular then L_1 can be either regular or non-regular.

Hence option (d) is correct.

5. (c)

Subset of regular language need not be regular

6. (3)

- L is regular if and only if $\bar{L}$ is regular.
- $L \cup \bar{L} = \Sigma^*$

Hence, all are correct statements.

7. (b, c)

(a) False:

$L_1 = \{\in\}$

$L_2 = a^+$

$L_1 \cap L_2 = \phi$

(b) True:

$L_1 \cup L_2$

$\{\in\} \cup \{a^+\} = a^*$

(c) True:

$L_1 = \{\in\}$

$\bar{L}_2 = \{\in\}$

$L_1 \cup \bar{L}_2 = \{\in\}$

Hence, option (c) is correct.

Branch : CSE & IT Batch : Hinglish

Subject : THEORY OF COMPUTATION

Chapter : Finite Automata

DPP 14

[MCQ]

1. Consider a regular language L.
If $L^* = \{a^{prime}\}^*$ is regular, then which of the following is true?
(a) $L = \{a^{prime}\}$ is regular
(b) $L = \{a^{prime}\}$ is not regular
(c) $L = \{a^{prime}\}$ is regular and finite.
(d) None of these.

[MSQ]

2. Consider a regular language L, which of the following statements are true regarding L.
(a) $Prefix(L) = \{w \mid ww_1 \in L, w_1 \in \Sigma^*\}$ is regular.
(b) $Suffix(L) = \{w \mid w_1w \in L, w_1 \in \Sigma^*\}$ is regular.
(c) $Half(L) = \{w \mid ww_1 \in L, |w| = |w_1|\}$ is regular.
(d) L is closed under infinite intersection.

[MCQ]

3. Let's consider L_1 and L_2 are two regular sets defined over (Σ = a, b), then
(a) $L_1 \cap L_2$ is irregular
(b) $L_1 \cup \overline{L_2}$ is not regular
(c) L_1^* is not regular
(d) $\Sigma^* - L_1$ is regular

[MCQ]

4. Let's suppose the languages $L_1 = \{a\}$ & $L_2 = \{\phi\}$. Then $L_2L_1^* \cup L_2^*$?
(a) $\{\phi\}$ (b) $\{\in\}$
(c) $\{a^*\}$ (c) $\{a\}$

[MCQ]

5. Consider a regular language L over the alphabet $\Sigma = \{a, b\}$. L is defined as $x = (a + b^*)(bab^*)$.
If homomorphism h is defined over T = {c, d, e} and
h(a) = cd
h(b) = cddec
Then the regular language h(L) is given as
(a) (cd + cddec) (cddec cd cddec)
(b) (cddec) (cd + cddec*)
(c) (cd + (cddec)*) ((cddec) (cd) (cddec)*)
(d) None of these

[MCQ]

6. Consider the following statements:
S_1: if $L_1 \cup L_2$ is regular, then both L_1 and L_2 are regular.
S_2: Regular language is closed under infinite union.
(a) S_1 is true.
(b) S_2 is true
(c) Both S_1 and S_2 are true
(d) Both S_1 and S_2 are false.

[MSQ]

7. Regular language is closed under
(a) Subset
(b) Complement
(c) Finite union
(d) Infinite Intersection

Answer Key

1. **(b)**
2. **(a, b, c)**
3. **(d)**
4. **(b)**
5. **(c)**
6. **(d)**
7. **(b, c)**

Hints & Solutions

1. (b)

If L^* is regular then L is need not to be regular.

Hence, If $L^* = \{a^{prime}\}^*$ is regular, then $L = \{a^{prime}\}$ is not regular. Hence, option (b) is correct.

2. (a, b, c)

Regular language is closed under Prefix, Suffix and half of the language. But regular language are not closed under infinite intersection.

So, a, b, c are correct.

3. (d)

(a) Regular language is closed under intersection, So

option (a) is false.

(b) Regular language is closed under complementation and union. Therefore, option (b) is false.

(c) Regular language is closed under kleene closure.

So, option (c) is false.

(d) $\Sigma^* - L_1 = \Sigma^* \cap \overline{L_1}$, Regular language is closed under intersection and complementation. So, option (d) is correct.

4. (b)

$L^* = L^0 \cup L^1 \cup L^2 \cup L^3 \ldots L^k \cup L^{k-1} \ldots$

we know, $L^0 = \in$.

ϕ acts as 0 in multiplication. So, concatenation of ϕ with any other language will result in ϕ.

Given,

$L_1 = \{a\}$

$L_2 = \phi$

$L_2 L_1^* \cup L_2^*$

$L_1^* = \{a\}^0 \cup \{a\}^1 \cup \{a\}^2 \ldots$

$= \in \cup a \cup aa \ldots$

$= a^*$

$L_2^* = \{\phi\}^0 \cup \{\phi\}^1 \cup \{\phi\}^2 \ldots$

$= \in \cup \phi \cup \phi \ldots$

$= \{\in\}$

$\therefore L_2 L_1^* \cup L_2^* = \phi \cdot a^* \cup \{\in\}$

$= \phi \cup \{\in\}$

$= \{\in\}$

So, option (b) is correct answer.

5. (c)

Homomorphism is a function from strings to string which is based on concatenation.

for any a and b $\in \Sigma^*, h(a,b) = h(a)h(b)$

L is defined as

$x = (a + b)^* (bab^*)$

then,

$h(L) = (h(a) + h(b)^* (h(b)h(a)h(b)^*)$

$= (cd + (cddec)^*)((cddec)(cd)(cddec)^*)$.

6. (d)

S_1: If $L_1 \cup L_2$ is regular, then L_1 and L_2 may be regular.

Consider $L_1 = \{a^n b^n, n \geq 0\}$ and consider L_2 be the complement of L1.

So, $L_1 \cup L_2 = \{a^n b^n\} \cup \{a^n b^n\}^c$

$= (a + b)^*$

this is regular but L_1 and L_2 are DCFL.

S_2: Regular language is not closed under infinite union.

7. (b, c)

Regular language are closed under complement and finite union.

Branch : CSE & IT **Batch : Hinglish**

Theory of Computation

Push Down Automata

DPP 01

[MCQ]

1. Consider the following grammar:

$S \rightarrow abSba|bSb|aSa|a|b|\in$

What is the language generated by above grammar?

(a) CFG that generates all palindromes over alphabet (a, b).

(b) CFG that generates all palindromes over alphabet (a, b) that do not contain substring "ab".

(c) CFG that generates all palindromes over alphabet (a, b) that contain substring "aa".

(d) CFG that generates all palindromes over alphabet (a, b) that do not contain substring "aa".

[MCQ]

2. Consider the following grammars:

G_1: $S \rightarrow aSc \mid \$\ B$

$B \rightarrow bBc \mid \$$

G_2: $S \rightarrow aaScc \mid \$\ B$

$B \rightarrow bBc \mid \$$

G_3: $S \rightarrow aSc \mid \$\ B$

$B \rightarrow bbBcc \mid \$$

Which of the following is true regarding G_1, G_2 and G_3?

(a) $L(G_1) \subseteq L(G_2), L(G_2) \subseteq L(G_3)$

(b) $L(G_2) \subseteq L(G_3), L(G_1) \subseteq L(G_3)$

(c) $L(G_1) \subseteq L(G_3), L(G_3) \subseteq L(G_2)$

(d) $L(G_2) \subseteq L(G_1), L(G_3) \subseteq L(G_1)$

[MCQ]

3. Consider the following context free grammar:

$S \rightarrow aA \mid aBB$

$A \rightarrow aaA \mid \in$

$B \rightarrow bB \mid bbC$

$C \rightarrow B$

What will be the equivalent simplified CFG for the given grammar?

(a) $S \rightarrow aA \mid a$

$A \rightarrow aaA \mid aa \mid b$

(b) $S \rightarrow aA \mid a$

$A \rightarrow aaA \mid aa$

(c) $S \rightarrow aAa \mid B$

$A \rightarrow aaA \mid aa$

$B \rightarrow bB \mid bb$

(d) $S \rightarrow aAa \mid B$

$A \rightarrow aA \mid b$

$B \rightarrow bB \mid bb \mid a$

[MSQ]

4. Consider the following grammar:

$S \rightarrow AB$

$A \rightarrow BaB \mid a$

$B \rightarrow bbA$

Which of the following is true regarding given grammar?

(a) Every string of the above grammar have at least two a's.

(b) Every string have three consecutive a's.

(c) Every string have alternate a and b.

(d) Every string have b's in multiple of 2.

[NAT]

5. Consider the following grammar G:

$S \rightarrow XA \mid BB$

$B \rightarrow b \mid SB$

$X \rightarrow b$

$A \rightarrow a$

After converting above grammar into GNF how many productions are there in the grammar?

[MSQ

6. Which of the following is true

(a) A grammar is called ambiguous if
(No. of parse tree's = No. of left most derivation = Number of Right most derivation) > 1

(b) Production of the form $A \rightarrow a$ is known as unit production.

(c) CNF is also known as binary standard form.

(d) In left-most derivation, right most non-terminal is substituted with its production to derive a string.

[MCQ]

7. Given the following two grammars:

G_1: $S \rightarrow AB \mid aaB$
$A \rightarrow a \mid Aa$
$B \rightarrow b$

G_2: $S \rightarrow aSbS \mid bSaS \mid \in$

What is true regarding above grammars?

(a) Both G_1 and G_2 are ambiguous.

(b) Both G_1 and G_2 are unambiguous.

(c) Only G_1 is ambiguous.

(d) Only G_1 is unambiguous.

[MCQ]

8. Consider the following languages

$L_1 = \{a^n b^{n+m} c^m \mid n, m \geq 0\}$

$L_2 = \{a^p b^q c^{p+q} \mid p, q \geq 0\}$

Which of the following is true?

(a) Only L_1 is Regular.

(b) Only L_2 is Regular.

(c) Both L_1 and L_2 are Regular.

(d) None of these

Answer Key

1. **(a)**
2. **(d)**
3. **(b)**
4. **(a, d)**
5. **(18)**
6. **(a, b, c)**
7. **(a)**
8. **(d)**

Hints & Solutions

1. (a)

Given

$S \rightarrow abSba \mid bSb \mid aba \mid a \mid b \mid \in$

Strings formed using above grammar are:

{∈, a, b, aa, bb, ...}

This is the CFG that generates all palindromes over alphabet (a, b).

So, option (a) is correct answer.

2. (d)

$L(G_1) = \{a^m \$ b^n \$ c^{m+n} \mid m, n \geq 0\}$

$L(G_2) = \{a^{2m} \$ b^n \$ c^{2m+n} \mid m, n \geq 0\}$

$L(G_3) = \{a^m \$ b^{2n} \$ c^{m+2n} \mid m, n \geq 0\}$

$\therefore$ It is clear,

$L(G_2) \subseteq L(G_1)$, and

$L(G_3) \subseteq L(G_1)$

Therefore, option d is correct.

3. (b)

Simplified CFG is a CFG without any null productions, unit-productions and useless symbol.

1. Elimination of NULL Productions:

   $A \rightarrow \in$

   Keep all the productions as it is and substitute ∈ in place of A.

   $S \rightarrow aA \mid aBB \mid a$

   $A \rightarrow aaA \mid aa$

   $B \rightarrow bB \mid bbC$

   $C \rightarrow B$

2. Eliminate Unit Productions: If the productions is of the form $A \rightarrow B$, the production is known as unit production. Eliminate unit production by replacing equivalent derivations.

   $S \rightarrow aA \mid aBB \mid a$

   $A \rightarrow aaA \mid aa$

   $B \rightarrow bB \mid bbB$

3. Eliminate useless symbol: The variables that are not involved the derivation of any string is known as useless symbol.

   In this question B is deriving bB | bbB which is entering into infinite loop. So, eliminating all productions of B.

   $S \rightarrow aA \mid a$

   $A \rightarrow aaA \mid aa$

Hence, options (b) is the correct answer.

4. (a, d)

The string produced by given grammar is

{abba, abbaabba, ……}

So option (a) and (d) are the true statements.

5. (18)

After converting the given grammar to GNF.

The final grammar will be.

$S \rightarrow bA \mid bB'B \mid bABB'B \mid bB \mid bABB$

$B \rightarrow bB' \mid bABB' \mid b \mid bAB$

$B' \rightarrow bB'BB' \mid bABB'\,BB' \mid bBB' \mid bABBB' \mid bB'B \mid bABB'B \mid bB \mid bABB$

$A \rightarrow a$

So, the total productions are 18.

6. (a, b, c)

According to definition of Ambiguous grammar, if there exist more than are parse tree for a string, then it is ambiguous grammar, option a is correct.

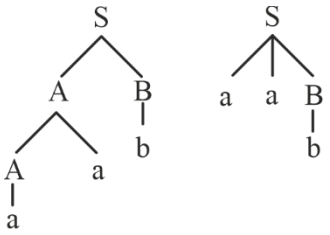
Production of the form $A \rightarrow a$ is known as unit production.

CNF is also known as binary standard form because the parse tree in CNF is always a binary tree.

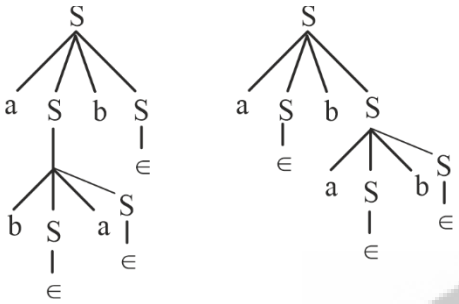
7. (a)

Both G_1 and G_2 are ambiguous, as both have multiple parse tree for same string.

G_1: aab



G_2: abab



8. (d)

$L_1 = \{\in, ab, bc, aabb, bbcc, \ldots\ldots\}$

$L_2 = \{\in, ac, bc, aacc, bbcc, \ldots\ldots\}$

Both the languages are CFL not regular.

Therefore option (d) is correct.

Branch : CSE & IT **Batch : Hinglish**

Theory of Computation

Push Down Automata

DPP 02

[MSQ]

1. Which of the following is string accepting mechanism of PDA.

(a) PDA using final state.
(b) PDA using empty stack.
(c) PDA using both empty stack and final state.
(d) PDA using transition state.

[MSQ]

2. Which of the following is correct push operation:

(a) Σ (q, a , b) = (q', ab)
(b) δ (q, a , b) = (q, ab)
(c) δ (q, a , b) = (q', ab)
(d) Σ (q, a , b) = (q', $\in$)

[NAT]

3. Consider the following statements:

(I) All DPDA are NPDA.
(II) All NPDA are DPDA.
(III) All NPDA and DPDA are equivalent.
(IV) All context free language are regular language.

The total number of correct statements are_____.

[MCQ]

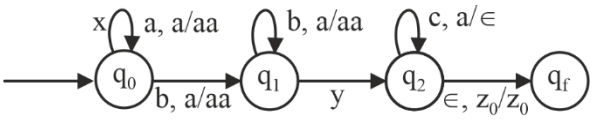
4. What does following transition means:

$\delta(q, \in, b) = (q', b)$

(a) Push b (b) Pop b
(c) Read b (d) No operation

[MCQ]

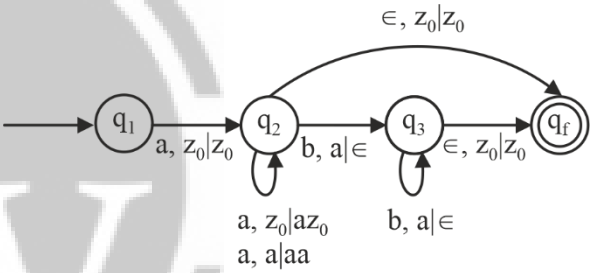
5. What are the values of x and y, if the language accepted by NPDA is $L = \{a^m b^n c^{(m+n)} \mid m, n \geq 1\}$.



(a) x = $\in$, a/a ; y = c, b/$\in$
(b) x = a, z_0/z_0 ; y = c, b/c
(c) x = a, a/aa ; y = b, c/c
(d) x = a, z_0/az_0 ; y = c, a/$\in$

[MCQ]

6. Which language is accepted by the following PDA.



(a) $L = \{a^n b^{n+1} \mid n \geq 1\}$
(b) $L = \{a^{n+1} b^m \mid n, m \geq 1\}$
(c) $L = \{a^{n+1} b^n \mid n \geq 0\}$
(d) $L = \{a^n b^{n+1} \mid n \geq 0\}$

[MSQ]

7. Which of the following languages are accepted by PDA.

(a) $L = \{a^n b^n c^m \mid m, n \geq 1\}$
(b) $L = \{a^n b^n c^m \mid m \leq n\}$
(c) $L = \{a^n b^m c^n d^m \mid m, n \geq 0\}$
(d) $L = \{a^m b^n c^n d^m \mid m, n \geq 0\}$

Answer Key

1. **(a, b, c)**
2. **(b, c)**
3. **(1)**
4. **(d)**
5. **(d)**
6. **(c)**
7. **(a, d)**

Hints & Solutions

1. (a, b, c)

PDA accepts string using final state, empty stack & both and all methods are equivalent.

2. (b, c)

$\delta(q, a, b) = (q, ab)$ is correct push operation on current state.

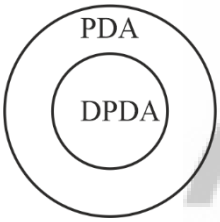
$\delta(q, a, b) = (q', ab)$ is the correct push operation

$\delta(q, a, b) = (q', ab)$

Push a

3. (1)

(I) All DPDA are PDA: correct



(II) All PDA are DPDA: incorrect

Some PDA are DPDA but all PDA are not DPDA.

(III) All PDA and DPDA care equivalent: incorrect

DPDA are subset of PDA. So all PDA and DPDA are not equivalent.

(IV) All context free language are regular language: incorrect

CFL are superset of RL. So, this statements is incorrect. However, all regular languages are context free languages.

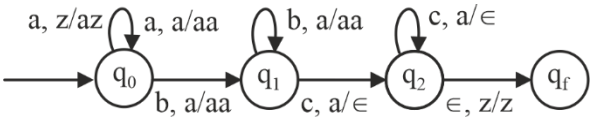
Therefore only 1 statement is correct.

4. (d)

$\delta(q, \in, b) = (q', b)$, this represents no operation is performed on stack. So, there is no change in the stack.

5. (d)

The PDA will be:



The x is to insert/push initial "a" into stack.

The y is to remove/pop an "a" for each "c".

6. (c)

$L = \{a^{n+1} b^n \mid n \geq 0\}$

$= \{a^1 \quad a^n \quad b^n \mid n \geq 0\}$

↓ ↓ ↓

Skip Push Pop

In the given PDA, first "a" is being skip. Then, for "n' number of 'a' are inserted and once 'b' starts appearing for each 'b', we will pop one "a".

Hence, option (c) is correct.

7. (a, d)

(a) $L = \{a^n b^n c^m \mid m, n \geq 1\}$

Push 'n' no of 'a'. pop 'a' for each 'b', skip 'c'.

It is accepted by PDA.

(b) $L = \{a^n b^n c^m \mid m \leq n\}$

Push 'n' no of 'a', pop 'a' for each 'b'. Since, it is given that $m \leq n$, so we can't compare number of c. Therefore, it is not acceptable using PDA.

(c) $L = \{a^n b^m c^c d^m \mid m, n \geq 0\}$

Unable to compare.

Therefore, it is not accepted by PDA.

(d) $L = \{a^m b^n c^n d^m \mid m, n \geq 0\}$

Push 'm' no. of "a". Push 'n' no. of "b".

Pop 'b' for each 'c'. Pop 'a' for each 'd'.

Hence, it is accepted by PDA.

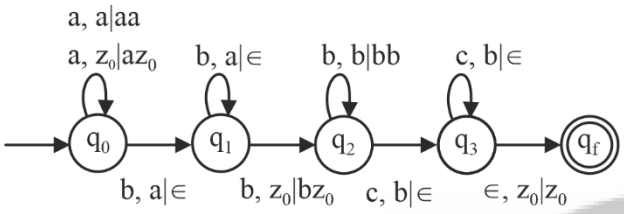
Branch : CSE & IT **Batch : Hinglish**

Theory of Computation
Push Down Automata

DPP 03

[MCQ]

1. The language derived by given PDA is



(a) $L = \{a^n b^m c^k \mid n = m + k, m, n, k \geq 0\}$.

(b) $L = \{a^m b^n c^k \mid k = m + n, m, n, k \geq 1\}$.

(c) $L = \{a^m b^n c^k \mid k = m + n, m, n, k \geq 0\}$.

(d) $L = \{a^m b^n c^k \mid n = m + k, m, n, k \geq 1\}$.

[NAT]

2. Consider the following statements:

(i) For every NFA N there exists a minimal DFA(N) such that L(N) = L(M).

(ii) For every DFA M there exists a DPDA P such that L(M) = L(P).

(iii) For every DPDA P there exists a NPDA N such that L(P) = L(N).

(iv) For every NPDA 'N' there exists a DPDA 'P' such that L(N) = L(P).

The number of correct statements is ____.

[MCQ]

3. Let $r_1 = (01^*)^*$ is any regular expression. Then which of the following regular expression represents r_2 such that $L(r_1) = L(r_2)$.

(a) $(10^*)^*$

(b) $(1^* + 01^*1)^*$

(c) $(0^* + 01^*1)^*$

(d) None

[MCQ]

4. Consider a, PDA M as defined below:

$M = \{\{q_0, q_1, q_2, q_3, q_4\}, \{a, b\}, \{a, b, z_0\}, \delta, q_0, \{q_4\}\}$ where δ is defined by

$\delta(q_0, a, z_0) = \{(q_1, az_0)\}$

$\delta(q_1, a, a) = \{(q_1, aa)\}$

$\delta(q_1, b, a) = \{(q_2, a)\}$

$\delta(q_2, b, a) = \{(q_2, a)\}$

$\delta(q_2, c, a) = \{(q_3, \in)\}$

$\delta(q_3, c, a) = \{(q_3, \in)\}$

$\delta(q_3, \in, z_0) = \{(q_4, \in)\}$

The above PDA accepts which language?

(a) $L(M) = \{a^n b^n c^m \mid n \geq 1, m \geq 0\}$

(b) $L(M) = \{a^n b^m c^n \mid n \geq 1, m \geq 0\}$

(c) $L(M) = \{a^n b^m c^m \mid n \geq 1, m \geq 0\}$

(d) $L(M) = \{a^n b^m c^n \mid n \geq 1, m \geq 1\}$

[MCQ]

5. Consider the following grammar G:

G:

$S \rightarrow SS \mid S$

$A \rightarrow aA$

Here, S and A are variables and a is a terminal then the language generated by above grammar G is:

(a) $L(G) = a^n$ (b) $L(G) = a^*$

(c) $L(G) = \phi$ (d) $L(G) = a^n b a^n$

[MSQ]

6. Which of the following is/are context free language.

(a) $L = \{a^m b^m c^n \mid m \geq 1 \text{ and } n \geq 1\}$

(b) $L = \{a^m b^m c^m \mid m \geq 0\}$

(c) $L = \{wcw^R \mid w \in (a + b)^+\}$

(d) All strings of balanced parenthesis

[MCQ]

7. Consider the following language L:

$L = \{wcw^R \mid w \in (a + b)^*, c \in (a + b)\}$

The complement of L will be _____.

(a) Regular

(b) DCFL but not regular

(c) CFL but not DCFL

(d) None of these

[NAT]

8. Suppose, L is a language accepted by PDA.

(i) $L = \{a^n b^n c^m d^m \mid n, m \geq 1\}$

(ii) $L = \{a^n \mid n \text{ is prime}\}$

(iii) $L = \{ww^R \mid w \in (a + b)^+\}$

Then how many of the following can be L_____.

Answer Key

1. **(d)**
2. **(3)**
3. **(c)**
4. **(d)**
5. **(c)**
6. **(a, c, d)**
7. **(c)**
8. **(2)**

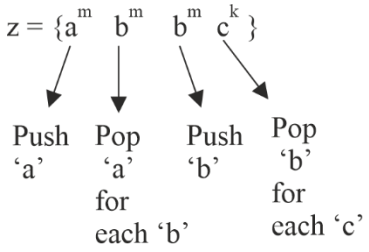
Hints & Solutions

1. (d)

The given PDA will generate language

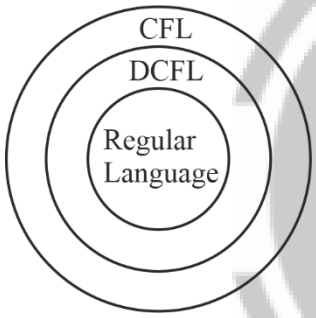
$L = \{a^m b^n c^k \mid n = m + k, m, n, k \geq 1\}$

$L = \{a^m b^{m+k} c^k\}$



2. (3)

(i) For every NFA N there exists a minimal DFA(N) such that L(N) = L(M). NFA and DFA are equivalent so this statement is true.



From above diagram, statement (ii) and (iii) are true.

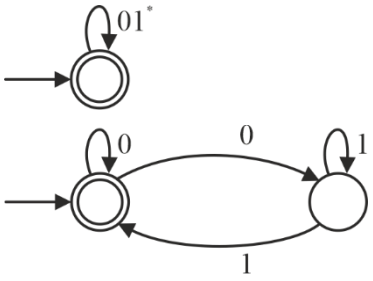
NPDA $\supseteq$ DPDA, so statement (iv) is false.

Therefore, 3 is correct answer.

3. (c)

$r_1 = (01^*)^*$

DFA:



$r_2 = (0^* + 01^*1)^*$

strings in $r_1 = \{\in, 0, 01, 011, 0101, 011011....\}$

The above expression is not producing 1, 111, ...

Therefore, option (a) and (b) are incorrect.

Option (c), producing all the strings produced by r_1.

$\therefore L(r_1) = L(r_2)$

4. (d)

The language accepted by above PDA is

$L(M) = \{a^n b^m c^n \mid n \geq 1, m \geq 0\}$

Push 'a' Skip 'b' Pop 'a' for each 'c'

Therefore, option (d) is correct answer.

5. (c)

The production $S \rightarrow SS$ is never generating any string.

Hence, the language will be $L = \{\phi\}$.

6. (a, c, d)

(a)

$L(M) = \{a^m b^m c^n \mid m \geq 1 \text{ and } n \geq 1\}$

Push 'a' Pop 'a' for each 'b' Skip 'c'

(b) We cannot compare no. of a's, b's with no. of c's. So not a CFL.

(c) $L = \{wcw^R \mid w \in (a + b)^+\}$ is context free language.

(d) All strings of balanced parenthesis are CFL.

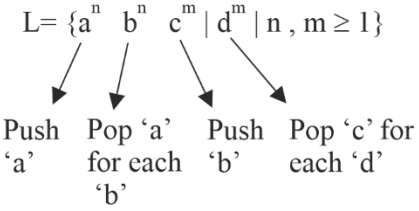
7. (c)

The complement of language L will have every even length string and it contain all odd length strings which are not in the from of wcw^R.

$\bar{L}$ is NCFL but not DCFL.

8. (4)

(i)



So, (i) is accepted by PDA

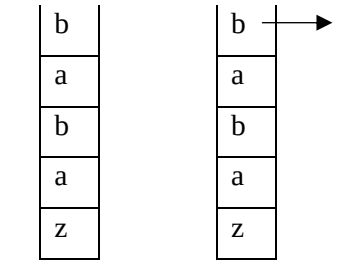
(ii) $L = \{a^n \mid n \text{ is prime}\}$

This is a non-CFL language because, we cannot pop all 'a's from stack.

(iii) $L = \{ww^R \mid w \in (a + b)^+\}$

Consider w = abab

So, w^R = baba



Push 'w' Pop 'w' for w^R

If TOS = symbol in string.

This can be accepted by PDA.

So, 2 is correct answer.

Theory of Computation

Push Down Automata

DPP 04

[MCQ]

1. Suppose L_1 is a finite language and L_2 is non-regular language then $L_1 \cap L_2$ will be:

(a) Regular but infinite
(b) Non-regular
(c) Finite and regular
(d) None of these

[NAT]

2. Consider a languages L:
$L = \{a^{29n+9} \mid n \geq 9\}$ then total number of minimum states in DFA will be_____.

[MSQ]

3. Consider the languages L = {ab, aa, baa} which of the following strings is/are in L^*.

(a) abaabaaabaa
(b) aaaabaaaa
(c) baaaaabaaaab
(d) baaaaabaa

[NAT]

4. Consider the following statements:

(i) All finite language are context free language.
(ii) All regular language are finite.
(iii) All DCFL are finite.
(iv) All regular language are DCFL
(v) There exists some language which are finite and irregular.

The number of correct statements from the above statements are_____.

[MCQ]

5. Consider the following languages.
$L_1 = \{a^n b^n \mid n \geq 0\}$
$L_2 = \{a^n b^m c^k \mid n, m, k \geq 0 \wedge n \neq m \vee m \neq k\}$
Which of the following statements is correct?

(a) L_1 is CFL and L_2 is DCFL
(b) L_1 is DCFL and L_2 is CFL
(c) L_1 and L_2 both are DCFL
(d) None of these.

[MSQ]

6. Which of the following grammar is/are generating DCFL but not regular language?

(a) $S \rightarrow aa\ S\ bb \mid \in$
(b) $S \rightarrow a\ S\ bb \mid \in$
(c) $S \rightarrow aa\ S\ b \mid \in$
(d) $S \rightarrow abS \mid \in$

[MCQ]

7. Consider the following languages:
$L_1 = \{a^m b^n c^k \mid \text{if } (m = \text{even}) \text{ then } (n = k)\}$
$L_2 = \{a^n c\ b^n\} \cup \{a^n d\ b^n\}$
Which of the following is correct statement?

(a) Only L_1 is DCFL.
(b) Only L_2 is DCFL.
(c) Both L_1 and L_2 are CFL but not DCFL
(d) Both L_1 and L_2 are DCFL but not regular.

[MCQ]

8. Consider the following grammar:
$S \rightarrow AB$
$A \rightarrow a\ A\ a \mid b\ A\ b \mid \in$
$B \rightarrow a\ B\ a \mid b\ B\ b \mid \in$
Which of the following is correct regarding above grammar?

(a) Language produced by S is $L = \{xx^R\ yy^R \mid x, y \in \{a, b\}^*\}$ and L is DCFL but not regular.
(b) Language produced by S is $L = \{xx^R\ yy^R \mid x, y \in \{a, b\}^*\}$ and L is CFL but not DCFL.
(c) Language produced by S is $L = \{xx^R\ yy^R \mid x, y \in \{a, b\}^*\}$ and L is DCFL.
(d) None of the above.

Answer Key

1. (c)
2. (270)
3. (a, b, d)
4. (2)
5. (b)
6. (a, b, c)
7. (d)
8. (b)

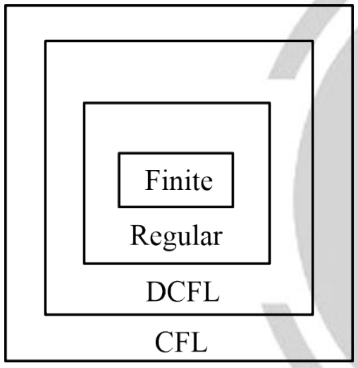
Hint & Solutions

1. (c)
Finite ∩ non-regular always finite.
Hence, option (c) is correct.

2. (270)
Number of states = 29 × 9 + 9 = 270.

3. (a, b, d)
(a) abaabaaabaa will be generated by L^*.
(b) aaaabaaaa will be generated by L^*.
(c) baaaaabaaaab will not be generated by L^*.
(d) baaaaabaa will be generated by L^*.

4. (2)



.

From above diagram, we can say that statement (i), (iv) are correct.

5. (b)
L_1 is DCFL and L_2 is CFL. So, option (b) is correct answer.

6. (a, b, c)
a, b, c are DCFL as they have comparison between number of a's & b's.

7. (d)
Both L_1 & L_2 are DCFL but not regular.

8. (b)
The given grammar will produce langauge
$L = \{xx^R\ yy^R \mid x, y \in \{a, b\}^*\}$ and the langauge is CFL but not DCFL.

Branch : CSE & IT **Batch : Hinglish**

Theory of Computation
Push Down Automata

DPP-05

[MCQ]

1. The intersection of CFL and a regular language will be
(a) Always regular
(b) Always CFL
(c) Always not regular
(d) None of these

[MCQ]

2. Consider the following grammars G_1, G_2 and G_3:

G_1 : $S \rightarrow P\ Q$
$P \rightarrow 0\ P\ 1 | \in$
$Q \rightarrow 1\ Q\ 2 | \in$

G_2 : $S \rightarrow 0\ S1 | Q$
$P \rightarrow 1Q\ 2 | \in$

G_3 : $S \rightarrow P\ Q \mid Q$
$P \rightarrow 0\ P\ 1 \mid 01$
$Q \rightarrow 1\ Q\ 2 | \in$

Here, {S,P,Q} are variables where S is start symbol. {0,1,2} are terminals.
Which of the following is true?
(a) G_1 and G_2 are equivalent.
(b) G_1 and G_3 are equivalent.
(c) G_2 and G_3 are equivalent.
(d) None of these.

[MSQ]

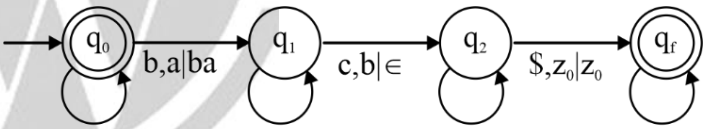
3. Consider the following regular expressions P, Q and R over $\sum = \{a, b\}$:
$P = ab + aQ + bR$
$Q = baQ + bR$
$R = Raba + a$
Which of the following regular expression will produce all the strings accepted by above regular expression?
(a) $ab + ba(aba)^* [\in + a(ba)^*]$
(b) $ab + [\in + a(ba)^*]\ ba(aba)^*$
(c) $ab + a(ba)^+\ ba(aba)^*$
(d) $ab + a(ba)^+ (aba)^* + ba(aba)^*$

[MCQ]

4. Consider the following language.
L_1 = Context free language.
L_2 = Deterministic context free language.
L_3 = Context sensitive language.
L_4 = Regular
Which of the following is incorrect?
(a) $L_2 . L_4$ is always DCFL.
(b) $L_1 \cap L_3$ is CSL.
(c) $\Sigma^* - L_3$ is CSL.
(d) None of the above.

[MCQ]

5. Consider the following push down automata.
$PDA = \{Q, \Sigma, \delta, \Gamma, q_0, Z_0, q_f\}$



$a,z_0 | az_0$
$a,a | aa$
$\$,a | a$
$b,b | bb$
$c,a | \in$
$c,b | \in$
$\$\ Z_0 \mid Z_0$

Which of the following language is accepted by above PDA?
(a) $L = \{a^*\} \cup \{a^p\ b^q\ c^r \mid p, q, r \geq 1, p + q = r\}$
(b) $L = \{a^{p+q}\ b^{q+r} \mid p, q, r \geq 0\}$
(c) $L = \{a^p\ b^q\ c^r \mid p, q, r \geq 1\}$
(d) None of the above

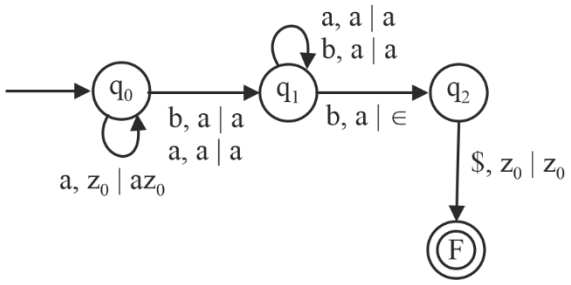
[MSQ]

6. Consider the following language:
$L_1 = \{ab^n a^{2n} \mid n \geq 1\}$
$L_2 = \{aab^n a^{3n} \mid n \geq 1\}$
Which of the following is correct?
(a) $L_1 \cup L_2$ is DCFL but not regular.
(b) $L_1 \cup L_2$ is CFL but not DCFL.
(c) $L_1 \cup L_2$ is CSL but not CFL.

(d) $L_1 \cup L_2$ is DCFL and also CFL.

[MCQ]

7. Consider the following PDA:



Here q_0 is a starting state and F is a final state. Then the language accepted by above PDA is?

(a) Regular but finite

(b) Regular but infinite

(c) CFL but not regular

(d) None of these

[MSQ]

8. Suppose, L is any CFL language on alphabet $\Sigma = \{a, b\}$, and the following language:

$L_1 = L - \{w\, x\, w^R \mid w, x \in \{a,b\}^*\}$

$L_2 = L_1 \cdot L$

$L_3 = \overline{L}_1 \cup L$

Which of the following is/are correct?

(a) L_1 is finite.

(b) L_2 is CFL.

(c) L_3 is regular.

(d) None of these.

Answer Key

1. **(b)**
2. **(b)**
3. **(b, d)**
4. **(a)**
5. **(a)**
6. **(a, d)**
7. **(b)**
8. **(a, b, c)**

Hints and Solutions

1. (b)

- CFL ∩ Regular
- Always CFL

Hence, option (b) is correct.

2. (b)

$L(G_1) = \{0^n1^n1^m\,2^m \mid m, n \geq 0\}$
$= \{0^n1^{m+n}\,2^m \mid m, n \geq 0\}$

$L(G_2) = \{0^m1^n\,2^n1^m \mid m, n \geq 0\}$

$L(G_3) = \{0^n\,1^{m+n}\,2^m \mid m, n \geq 0\}$

Hence, option (b) is correct.

3. (b, d)

$P = ab + aQ + bR$

$Q = baQ + bR$

$R = Raba + a$

Apply Arden's Theorem:

$R = a(aba)^*$

$Q = (ba)^*bR$

$Q = (ba)^*ba(aba)^*$

$P = ab + aQ + bR$

$P = aQ \mid bR \mid ab$

$= a[(ba)^*ba(aba)^*] + ba(aba)^* + ab$

$r * r = r^+$

$(ba)^*ba = (ba)^+$

$P = a(ba)+ (aba)^* + ba(aba)^* + ab$

Exactly match with option (d)

$P = a[(ba)^* \underline{ba(aba)^*}] + \underline{ba(aba)^*} + ab$

$P = [a(ba)^* + \in]ba(aba)^* + ab$

$= ab + [\in + a(ba)^*]ba(aba)^*$

Exactly match with opetion (b)

Hence, option (b, d) are correct.

4. (a)

(a) DCFL·Regular ↑

DCFL· DCFL

CFL **(False)**

(b) CFL ∩ CSL

CSL ∩ CSL

CSL **(True)**

(c) $\Sigma^* - CSL$

$\Sigma^* \cap \overline{CSL}$

CSL

Hence, option (a) is correct.

5. (a)

- State q_0 will accept all the a's i.e. a*

At state q_f

Number of C = number of a's + number of b's

So, $L = \{a^*\} \cup \{a^p b^q c^r \mid p + q = r, p, q, r \geq 1\}$

Hence, option (a) is correct.

6. (a, d)

- $L_1 = \{ab^na^{2n} \mid n \geq 1\}$ is DCFL
  $L_2 = \{aab^na^{3n} \mid n \geq 1\}$ is DCFL
- $L_1 \cup L_2$ will be DCFL for
  L_1 skip first a and for L_2 skip
  2 a's. Push and pop are clear so
  $L_1 \cup L_2$ will be DCFL but not regular
- Every DCFL is CFL also.

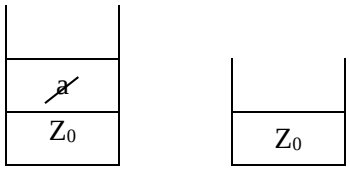
Hence, option (a, d) is correct

7. (b)

- In given PDA first a will be pushed into stack

a
Z_0

- After first 'a' it will skip all the a's and b's
- And it will be pop 'a' on last input b.



empty stack

Regular expression = a $(a + b)^*$ b (regular but infinite)

Hence, option (b) is correct.

8. (a, b, c)

L_1 = CFL – $(a + b)^*$

= CFL $\cap$ $[(a+b)^*]^C$

= ϕ

L_2 = ϕ . CFL

= ϕ

L_3 = $\bar{\phi} \cup$ CFL

= $(a + b)^* \cup$ CFL

= $(a + b)^*$

(a) L_1 = finite true

$L_1 = \phi$

(b) L_2 is CFL

$L_2 = \phi$ is regular and every regular is CFL.

(c) L_3 is regular

$L_3 = (a + b)^*$

Hence, (a, b, c) are correct option

Branch : CSE & IT **Batch : Hinglish**

Theory of Computation

Turing Machine Recursively Enumerable

DPP 01

[MCQ]

1. Let M be a turing machine having Q = {q_0, q_1, q_2, q_3, q_4} a set of states, input alphabet {0, 1}. The tape alphabets {0, 1, B, x, y}. The symbol B is used to represent the end input string. The initial and final states are q_0 and q_4 respectively. The transitions are as follows:

1. $(q_0, 0) = (q_1, x, R)$ **2.** $(q_0, y) = (q_3, y, R)$
3. $(q_1, 0) = (q_1, 0, R)$ **4.** $(q, 1) = (q_2, y, L)$
5. $(q_1, y) = (q_1, y, R)$ **6.** $(q_2, 0) = (q_2, 0, L)$
7. $(q_2, x) = (q_0, x, R)$ **8.** $(q_2, y) = (q_2, y, L)$
9. $(q_3, y) = (q_3, y, R)$ **10.** $(q_3, B) = (q_4, B, R)$

Which of the following statement is true about M?

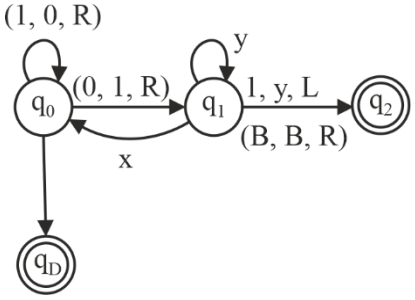
(a) M accepts on L = $\{0^n 1^m \mid n, m \geq 0\}$.
(b) M accepts 010 as a substring.
(c) M accepts on L = $\{0^n 1^n \mid n \geq 0\}$.
(d) M accepts on 011 as a substring.

[MCQ]

2. Consider the following turing machines:
(i) Single-tape TM
(ii) Multi-tape TM
(iii) Universal TM
Which of the above TM's are equivalent?
(a) (i) and (ii) (b) (ii) and (iii)
(c) (i) and (iii) (d) (i), (ii), and (iii)

[MSQ]

3. If the following turing machine accepts L = $\{(0 + 1)^*\}$, then what will the value of x and y?



(a) x = (1, 1, R); y = (0, 0, R)
(b) x = (1, 0, R); y = (0, 1, R)
(c) x = (1, 1, R); y = (1, 1, R)
(d) x = (0, 1, R); y = (1, 0, R)

[MCQ]

4. Which of the following statement is/are correct regarding tuples of turing machine
(a) TM has six tuples which are {Q, T, Σ, δ, q_0, F}.
(b) Σ is the input alphabet.
(c) T is the tape alphabet.
(d) Q is finite set of states.

[MCQ]

5. Consider a Turing machine with following restrictions
(i) Head can only read and cannot write.
(ii) Head can move only in one direction.
The Turing machine with above restrictions is known as _____.
(a) Turing machine
(b) Linear bounded automata
(c) Push down automata
(d) Finite Automata

[MCQ]

6. Consider the given grammar:
$S \rightarrow aASccc \mid \in$
$Aa \rightarrow aA$
$Ac \rightarrow bbc$
$Ab \rightarrow bbb$
Which of the following language is derived by the above grammar?
(a) L = $\{a^n b^n c^n \mid n \geq 0\}$
(b) L = $\{a^n b^{2n} c^n \mid n \geq 0\}$
(c) L = $\{a^n b^{2n} c^{3n} \mid n \geq 0\}$
(d) L = $\{a^{4n} b^{3n} c^{2n} \mid n \geq 0\}$

[MCQ]

7. Consider the following transitions of a turing machine M:

$\delta(q_0, a) = (q_1, B, R)$

$\delta(q_0, b) = (q_1, B, R)$

$\delta(q_0, B) = (q_3, B, R)$

$\delta(q_1, b) = (q_2, B, R)$

$\delta(q_1, a) = (q_2, B, R)$

$\delta(q_2, a) = (q_0, B, R)$

$\delta(q_2, b) = (q_0, B, R)$

The language derived by the equivalent turing machine defined as?

(a) L = {w: |w| is even}

(b) L = {w: |w| is odd}

(c) L = {w: |w| is multiple of 3}

(d) None of these

[MCQ]

8. Minimum number of stacks required by push down automata to behave like a turing machine.

(a) 1 (b) 2

(c) 3 (d) None of these

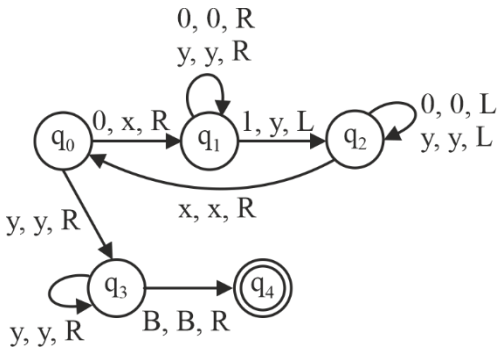
Answer Key

1. **(c)**
2. **(d)**
3. **(a, b, d)**
4. **(b, c, d)**
5. **(d)**
6. **(c)**
7. **(c)**
8. **(b)**

Hints & Solutions

1. (c)

Turing machine for the given transitions



The above turing machine M accepts on L = $\{0^n 1^n \mid n \geq 0\}$

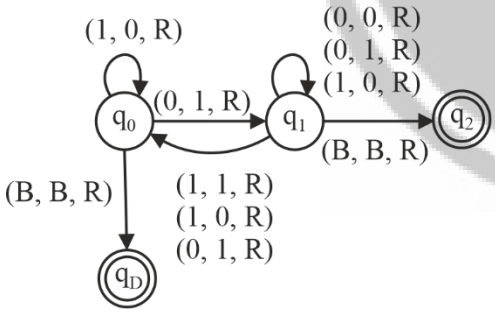
$\therefore$ option (c) is correct.

2. (d)

All turing machine can solve same set of problem. However, complexity of solving a problem may differ.

3. (a, b, d)

Turing machine for accepting $(0 + 1)^*$ is as follows:



So, clearly option (a), (b) and (d) are correct.

4. (b, c, d)

TM has seven tuples which are (Q, T, B, Σ, δ, q_0, F).

Σ is the input alphabet. Correct.

T is the tape alphabet. Correct.

Q is the finite set of states. Correct.

$\therefore$ (b), (c), (d) are correct.

5. (d)

If a turing machine has unidirectional and read only head so it can only accept regular languages and acts like a finite automata.

6. (c)

String derived by given grammar are:

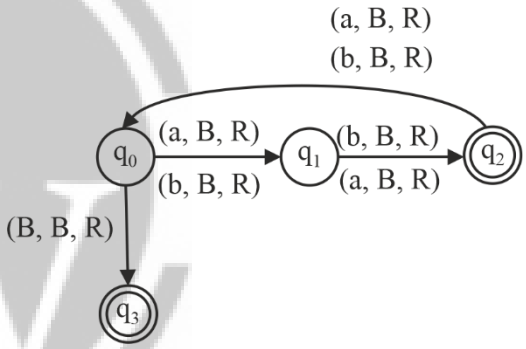
{∈, abbccc, aabbbbcccccc, ……}

So, the L = $\{a^n b^{2n} c^{3n} \mid n \geq 0\}$

$\therefore$ Option (c) is correct.

7. (c)

The equivalent turing machine for given transitions is:



It can be seen the language contain strings whose length is multiple of 3.

8. (b)

Push down automata with 2 or more stacks is equivalent to turing machine.

Branch : CSE & IT **Batch : Hinglish**

Theory of Computation

Turing Machine Recursively Enumerable

DPP 02

[MCQ]

1. Which of the following statement is correct?

(a) Every NTM (Non-deterministic Turing Machine) can be converted into DTM (Deterministic Turing Machine).

(b) Every DTM (Deterministic Turing Machine) can be converted into NTM (Non-deterministic Turing Machine).

(c) Both (a) and (b)

(d) None of these

[MSQ]

2. Which of the following statement is/are true regarding halting of turing machine?

(a) If head of TM always move right, then TM never halts.

(b) If head of TM always move left, then TM may halt.

(c) If head of TM always move left, then TM never halts.

(d) If head of TM moves in right and sometimes in left (loop), then also the never halts.

[MCQ]

3. Given transition table of turing machine is as follow:

	0	1
$\rightarrow q_0$	q_0, 0, R	q_1, 0, R
q_1	q_0, 1, R	q_1, 1, R

If q_0 is initial state and q_1 is final state, which of the following language is accepted by given turing machine?

(a) Set of all string ending with 1.

(b) Set of all string ending with 11.

(c) Set of all string starting with 0.

(d) Set of all string starting with 10.

[MSQ]

4. Which of the following is/are true?

(a) There exist no recursive enumerable language that is recursive language.

(b) If L is CFL, then complement of L may be CFL.

(c) There exist no recursive language that is not recursively enumerable.

(d) If L is CFL, then complement of L may be CSL.

[MSQ]

5. Which of the following has the same computational power as of turing machine?

(a) PDA with additional 2 stack.

(b) PDA with additional 1 stack.

(c) FA with additional 1 counter.

(d) FA with additional 2 counter.

[MCQ]

6. Which of the following is a correct transition function of DTM?

When

Q = Set of state

Σ = Input alphabet

Γ = Tape alphabet

F = Final state

δ = Transition function

(a) $\delta : Q \times \Sigma \rightarrow Q \times \Gamma \times F$

(b) $\delta : Q \times \Sigma \rightarrow Q \times \Sigma \times \{L, R\}$

(c) $\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\}$

(d) $\delta : Q \times \Gamma \rightarrow Q \times \Sigma \times F$

[NAT]

7. How many of the following languages are context sensitive language?

(i) $L = \{a^{n^2} \mid n \geq 0\}$

(ii) $L = \{a^n b^m c^n d^m \mid n, m \geq 0\}$

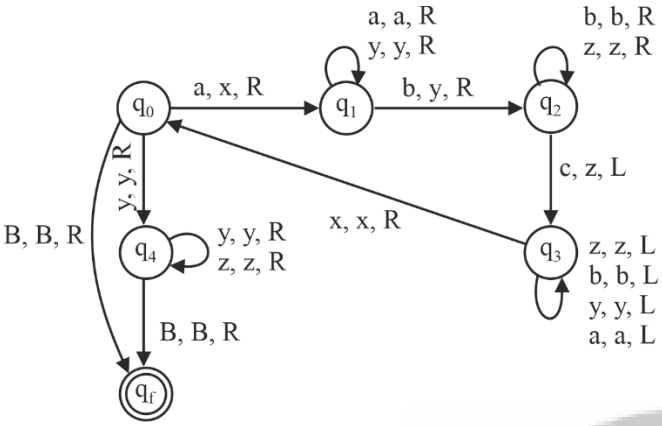
(iii) $L = \{a^n b^m c^m d^n e^f \mid n, m, f \geq 0\}$

(iv) $L = \{wx\, w^R \mid x, w \in (0, 1)^*\}$

(v) $L = \{a^n b^{n^2} \mid n \geq 0\}$

[MCQ]

8. Consider the following turing machine:



Which of the following language is accepted by given turing machine?

(a) $\{L = \{a^m b^n c^p \mid m, n, p \geq 0\}$

(b) $\{L = \{a^m b^n c^p \mid m, n \geq 0\}$

(c) $\{L = \{a^m b^m c^m \mid m \geq 0\}$

(d) $\{L = \{a^m b^{2m} c^{3m} \mid m \geq 0\}$

Answer Key

1. **(c)**
2. **(a, c, d)**
3. **(a)**
4. **(c, d)**
5. **(a, b, d)**
6. **(c)**
7. **(3)**
8. **(c)**

Hints & Solutions

1. (c)

Every DTM can be converted into NTM and every NTM can be converted into DTM.

DTM ≅ NTM

2. (a, c, d)

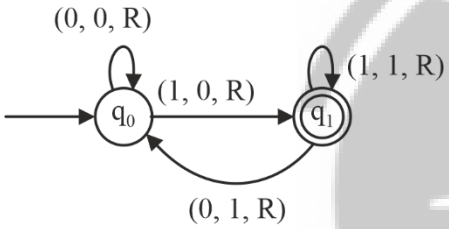
(a) If head of TM always move right, then TM never halts.

(c) If head of TM always move left, then TM never halts.

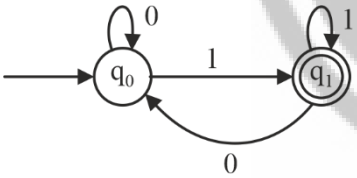
(d) If head of TM moves in right and sometimes in left (loop), then also the never halts.

Those three statements are true.

3. (a)



This turing machine is equivalent to following finite automata.



Language accepted by the given turing machine:

$(0 + 1)^* 1$

4. (c, d)

Recursive language subsets of REL's. Therefore, option (a) is false and option (c) is true.

All recursive language are recursive enumerable languages.

CFL's are not closed under complementation. Therefore, option (b) is false and option (d) is true.

5. (a, b, d)

PDA with additional 2 stack and PDA with 1 stack and FA with 2 counter has the same computational power as of turing machine.

Therefore, option (a), (b) and (d) are correct.

6. (c)

Transition function for DTM is defined as:

$Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\}$

So, option (c) is correct.

7. (c)

(i) $L = \{a^{n^2} \mid n \geq 0\}$. This is CSL

(ii) $L = \{a^n b^m c^n d^m \mid n, m \geq 0\}$. This CSL

(iii) $L = \{a^n b^m c^m d^n e^f \mid n, m, f \geq 0\}$. This is DCFL

(iv) $L = \{wx\, w^R \mid x, w \in (0, 1)^*\}$. This is regular

(v) $L = \{a^n b^{n^2} \mid n \geq 0\}$. This is CSL.

So, (i), (ii), and (v) are CSL.

8. (c)

The given turing machine accepts such as

{∈, abc, aabbcc, aaabbbccc, ….}.

Therefore, $L = \{a^m b^m c^m \mid m \geq 0\}$ is correct answer.