Fully Solved

2650 MCQs

Useful For

GATE and PSUs

Computer Science and Information Technology

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PREFACE

B. Singh (Ex. IES)

It gives me great happiness to introduce the **First Edition** on Computer Science and Information Technology containing nearly 2650 MCQs which focuses in-depth understanding of subjects at basic and advanced level which has been segregated topicwise to disseminate all kind of exposure to students in terms of quick learning and deep apt. The topicwise segregation has been done to align with contemporary competitive examination pattern. Attempt has been made to bring out all kind of probable competitive questions for the aspirants preparing for GATE and PSUs. The content of this book ensures threshold level of learning and wide range of practice questions which is very much essential to boost the exam time confidence level and ultimately to succeed in all prestigious engineer's examinations. It has been ensured from MADE EASY team to have broad coverage of subjects at chapter level.

While preparing this book utmost care has been taken to cover all the chapters and variety of concepts which may be asked in the exams. The solutions and answers provided are upto the closest possible accuracy. The full efforts have been made by MADE EASY Team to provide error free solutions and explanations.

I have true desire to serve student community by way of providing good sources of study and quality guidance. I hope, this book will be proved an important tool to succeed in competitive examinations. Any suggestions from the readers for the improvement of this book are most welcome.

B. Singh (Ex. IES)
Chairman and Managing Director
MADE EASY Group

CONTENTS

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CHAPTER 1

Basic Level

Theory of Computation

1. Finite Automata: Regular Languages

Q.1 Which of the following is false?
(a) The languages accepted by FA's are regular languages.
(b) Every DFA is an NFA.
(c) There are some NFA's for which no DFA can be constructed.
(d) If L is accepted by an NFA with $\in$ transition then L is accepted by an NFA without $\in$ transition.

Q.2 Let $r_1 = ab^*c^*$ and $r_2 = (a^*b + c)^*$ and $r_3 = (a + b + c)^*$. Then which of the following is true
(a) w = 'ac' belongs to $L(r_2)$ and $L(r_3)$ but not $L(r_1)$
(b) w = 'ac' belongs to $L(r_3)$ only
(c) w = 'ac' belongs to $L(r_1)$, $L(r_2)$ and $L(r_3)$
(d) w = 'ac' belongs to $L(r_1)$ and $L(r_3)$ but not $L(r_2)$

Q.3 Let $\Sigma = \{a, b\}$, $r_1 = a(a + b)^*$ and $r_2 = b(a + b)^*$. Which of the following is true?
(a) $L(r_1) = L(r_2) = \Sigma^*$
(b) $L(r_1) \cap L(r_2) = \{\in\}$
(c) $L(r_1) \cup L(r_2) = \Sigma^*$
(d) $L(r_1) \cup L(r_2) \cup \{\in\} = \Sigma^*$

Q.4 Which of the following statements are true?
(i) $abcd \in L((b^*a^*)^* (d^*c^*)^*)$
(ii) $abcd \in L((d^*c^*b^*a^*)^*)$
(iii) $abcd \in L((a^*b^*a^*c^*d^*)^*)$
(a) (i) and (iii) only (b) (ii) and (iii) only
(c) (i) and (ii) only (d) All of these

Q.5 Which of the following are regular languages?
(i) The language $\{w \mid w \in \{a, b\}^*$, w has an odd number of b's$\}$.
(ii) The language $\{w \mid w \in \{a, b\}^*$, w has an even number of b's$\}$.
(iii) The language $\{w \mid w \in \{a, b\}^*$, w has an even number of b's and odd number of a's$\}$.
(a) (i) and (ii) only (b) (i) only
(c) (ii) only (d) All of these

Q.6 Which of the following regular expression corresponds to the language of all strings over the alphabet $\{a, b\}$ that contains exactly two a's
(i) aa
(ii) ab^*a
(iii) $b^*\, ab^*a$
(a) (i) and (ii) only (b) (ii) and (iii) only
(c) (i) and (iii) only (d) None of these

Q.7 Which of the following regular expression corresponds to the language of all strings over the alphabet $\{a, b\}$ that do not end with ab?
(a) $(a + b)^*\, (aa + ba + bb)$
(b) $(a + b)^*\, (aa + ba + bb) + a + b + \in$
(c) $b^*\, ab^*\, a$
(d) $b^*\, aa\, b^*$

Q.8 What is regular expression corresponding to the language of strings of even lengths over the alphabet of $\{a, b\}$?
(a) $(aa + bb + ba + ab)^*$
(b) $(aa + bb)^*$
(c) $(ab + bb + ba)^*$
(d) $a^*b^*a^*b^*$

Q.9 How many minimum number of states will be there in the DFA accepting all strings (over the alphabet $\{a,b\}$) that do not contain two consecutive a's?
(a) 2 (b) 3
(c) 4 (d) 5

Q.10 How many minimum number of states are required in the DFA (over the alphabet $\{a, b\}$) accepting all the strings with the number of a's divisible by 4 and number of b's divisible by 5?
(a) 20 (b) 9
(c) 7 (d) 15

Q.11 Which of the following definitions below generates the same language as L where $L = \{x^n y^n \mid n >= 1\}$?
(i) $E \rightarrow xEy \mid xy$
(ii) $xy \mid (x^+ y^+)$
(iii) $x^+ y^+$
(a) (i) only (b) (i) and (ii) only
(c) (ii) and (iii) (d) (i) and (iii) only

Q.12 Let $X = \{0, 1\}$, $L = X^*$ and $R = \{0^n 1^n \mid n > 0\}$ then the language $L \cup R$ and R respectively
(a) Regular, Regular
(b) None regular, Regular
(c) Regular, Not regular
(d) Not regular, Not regular

Q.13 How many states does the DFA constructed for The set of all strings ending with "00", have?
(a) 2 (b) 3
(c) 4 (d) 5

Q.14 Which of the following identities are correct?
(a) $rs^* = rss^*$ (b) $(r^*s^*) = (r + s)^*$
(c) $(r + s)^* = r^* + s^*$ (d) $(r^*s^*)^* = (r + s)^*$

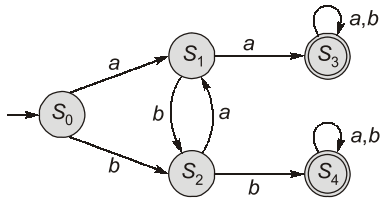
Q.15 Let L_1 and L_2 are regular sets defined over alphabet Σ^*. Mark the false statement
(a) $L_1 \cup L_2$ is regular (b) $L_1 \cap L_2$ is not regular
(c) $\Sigma^* - L_1$ is regular (d) L_1^* is regular

Q.16 Consider $L_1 = \{0^n 1^n \mid n \geq 1\}$, $L_2 = \{0^n c 1^n \mid n \geq 1\}$
(i) L_1 and L_2 are accepted by non-deterministic PDA.
(ii) L_1 and L_2 are accepted by deterministic PDA.
(iii) Only L_2 is accepted by deterministic PDA.
Which of the following statements are correct?
(a) Only (i) (b) (i) and (ii)
(c) (i) and (iii) (d) All (i), (ii), (iii)

Q.17 Suppose $r_1 = \epsilon$, $r_2 = 0^* 1^*$, which of the following statement is true about r_1 and r_2?
(a) r_1 is not regular expression, while r_2 is a regular
(b) r_1 and r_2 both are regular expression
(c) r_1 is regular expression but r_2 not
(d) Neither r_1 nor r_2 are regular expressions

Q.18 The transition function of DFA from one state to another on a given input symbol w is a function $Q \times \Sigma^*$ to
(a) 2^Q (b) Q
(c) Q' (d) Q^2

Q.19 Consider the machine M shown below:



$L(M)$ = ?
(a) $L(M)$ = {words starting with *aa* or *bb*}
(b) $L(M)$ = {words ending with *aa* or *bb*}
(c) $L(M)$ = {words containing *aa* or *bb* as *a* subword}
(d) None of these

Q.20 Let $L = \{w \mid w \text{ has } 3k + 1\ b\text{'s } \forall k \geq 0\}$, construct a minimized finite automata D accepting L. How many states are there in D?
(a) 4
(b) 3
(c) 2
(d) The language is not regular

Q.21 Which of the following is undecidable?
(a) Equivalence of regular languages
(b) Equivalence of context free languages
(c) Finiteness check on context free language
(d) Emptiness of regular languages

Q.22 Let, $L_1 = \{a^n b^n c^n \mid n \geq 0\}$
$L_2 = \{a^{2n} b^{2n} c^{2n} \mid n \geq 0\}$
$L_3 = \{a^{2n} b^{2n} c^n \mid n \geq 0\}$
(a) $L_1 \subseteq L_2$ and $L_3 \subseteq L_2$
(b) $L_2 \subseteq L_1$ and $L_2 \subseteq L_3$
(c) $L_2 \subseteq L_1$ but $L_2 \not\subset L_3$
(d) $L_1 \subseteq L_2$ and $L_2 \subseteq L_3$

Q.23 Suppose $L_1 = \{10, 1\}$ and $L_2 = \{011, 11\}$. How many distinct elements are there in $L = L_1 L_2$.
(a) 4 (b) 3
(c) 2 (d) None of these

Q.24 Which of the following regular expression does not represent strings beginning with atleast one 0 and ends with at least one 1?
(a) 0*1* (b) 00*(0 + 1)*1
(c) 0(0 + 1)*1 (d) None of these

Q.25 Strings generated by (1 + 01)* does not contain the substring,
(a) 10 (b) 11
(c) 01 (d) 00

Q.26 The following CFG:

$$S \to aS \mid bS \mid a \mid b$$

is equivalent to the regular expression

1. $(a^* + b)^*$
2. $(a + b)^+$
3. $(a + b)(a + b)^*$
4. $(a + b)^*(a + b)$

(a) 2 and 3 only (b) 2, 3 and 4
(c) All of the above (d) 3 and 4 only

Q.27 The Moore machine has six tuples

$$(Q, \Sigma, \Delta, \delta, \lambda, q_0)$$

Which of the following is true?
(a) δ is the output function
(b) δ is the transition function $\Sigma \to Q$
(c) λ is the transition function $\Sigma \times Q \to Q$
(d) λ is the output function mapping $Q \to \Delta$

Q.28 For the previous question, δ is the transition function from
(a) $Q \to R$ (b) $\delta \times \Sigma \to d$
(c) $\Sigma \times Q \to Q$ (d) None of these

Q.29 The regular expression for "Binary numbers that are multiples of two" is
(a) $(0 + 1)^*.1$ (b) $(0 + 1)^*.0$
(c) $(1 + 0)^*.1$ (d) $(1 + 0)^*.00$

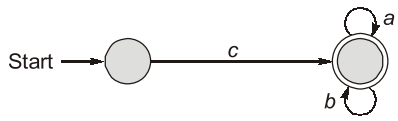
Q.30 The regular expression for "strings of a's and b's containing two consecutive a's" is
(a) $(a + b)^* ab(a + b)^*$
(b) $(a+b)^* bb(a + b)^*$
(c) $(a + b)^* aa(a + b)^*$
(d) $(a + b)^* ba(a + b)^*$

Q.31 The regular expression that describe the language generated by the grammar:

$$G = (\{T,Z\},\{a,b\}\, Z,\{Z \to aZ \mid \in \mid ,Z \to bT,\ T \to aZ\})$$

(a) ab^*a^* (b) a^*ba^*b
(c) $ab^*a\,a$ (d) $(a + ba)^*$

Q.32 Which of the string is accepted by given NDFA?



(a) $c.(a + b)^*$ (b) $c.a^*b^*$
(c) $c.(ab)^*$ (d) None of these

Q.33 The regular expression $(a \mid b)(a \mid b)$ denotes the set
(a) $\{a, b, ab, aa\}$ (b) $\{a, b, ba, bb\}$
(c) $\{a, b\}$ (d) $\{aa, ab, ba, bb\}$

Q.34 Let a and b the regular expressions then $(a^* + b^*)^*$ is not equivalent to
(a) $(b^* + a^*)^*$ (b) $(a + b)^*$
(c) $(b + a)^*$ (d) $a + b$

Q.35 Consider the following regular expression:

$$R = (ab \mid abb)^* bbab$$

Which of the following strings is NOT in the set denoted by R?
(a) *ababbab* (b) *ababbabbbab*
(c) *bbab* (d) *abbabbbab*

Q.36 The following GFG:
$S \to aS \mid bS \mid a \mid b$ and $S \to aS \mid bS \mid a \mid b \mid \in$ is equivalent to regular expressions
(a) $(a + b)$ and $\in + a + b$ respectively
(b) $(a + b)(a + b)^*$ and $(a + b)^*$ respectively
(c) $(a + b)(a + b)$ and $(\in + a + b)(\in + a + b)$ respectively
(d) None of the above

Q.37 Which of the following pairs of regular expression are not equivalent?
(a) $(ab)^* a$ and $a(ba)^*$
(b) $(a + b)^*$ and $(a^* + b)^*$
(c) $b^* ab^*$ and $a^* ba^*$
(d) All of the above

Q.38 Can a DFA simulate NFA?
(a) No (b) Yes
(c) Some time (d) Depends on NFA

Q.39 The basic limitation of FSM is that
(a) It can not remember arbitrary large amount of information.
(b) It sometimes fails to recognize grammars that are not regular.
(c) It sometimes fails to recognize grammars that are regular.
(d) All of these

Q.40 Any given transition diagram has an equivalent
(a) Regular expression
(b) NDFSM
(c) DFSM
(d) All of these

Q.41 The set $\{a^n b^n \mid n = 1, 2, 3, \ldots\}$ can be generated by the CFG
(a) $S \to ab \mid aSb \mid \in$ (b) $S \to aaSbb \mid ab$
(c) $S \to ab \mid aSb$ (d) None of these

Q.108 Which of the following problems is undecidable?
(a) Membership problem for CFGs
(b) Ambiguity problem for CFGs
(c) Finiteness problem for FSAs
(d) Equivalence problem for FSAs

Q.109 Which of the following is true for the language $\{a^p \mid p \text{ is a prime}\}$?
(a) It is not accepted by a Turning Machine
(b) It is regular but not context-free
(c) It is context-free but not regular
(d) It is neither regular nor context-free, but accepted by a Turing machine

Q.110 Which of the following are decidable?
1. Whether the intersection of two regular languages is infinite.
2. Whether a given context-free language is regular.
3. Whether two push-down automata accept the same language.
4. Whether a given grammar is context-free.

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

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Answers Theory of Computation

1.	(c)	2.	(d)	3.	(d)	4.	(d)	5.	(d)	6.	(d)	7.	(b)	8.	(a)	9.	(b)	10.	(a)
11.	(a)	12.	(c)	13.	(b)	14.	(d)	15.	(b)	16.	(b)	17.	(b)	18.	(b)	19.	(c)	20.	(b)
21.	(a)	22.	(c)	23.	(a)	24.	(a)	25.	(d)	26.	(b)	27.	(d)	28.	(c)	29.	(b)	30.	(c)
31.	(d)	32.	(a)	33.	(d)	34.	(d)	35.	(a)	36.	(b)	37.	(c)	38.	(b)	39.	(a)	40.	(d)
41.	(c)	42.	(c)	43.	(b)	44.	(d)	45.	(d)	46.	(c)	47.	(b)	48.	(a)	49.	(c)	50.	(c)
51.	(d)	52.	(b)	53.	(c)	54.	(b)	55.	(d)	56.	(a)	57.	(d)	58.	(b)	59.	(c)	60.	(d)
61.	(a)	62.	(c)	63.	(c)	64.	(a)	65.	(d)	66.	(d)	67.	(a)	68.	(c)	69.	(b)	70.	(b)
71.	(c)	72.	(b)	73.	(d)	74.	(c)	75.	(a)	76.	(b)	77.	(a)	78.	(a)	79.	(b)	80.	(d)
81.	(b)	82.	(d)	83.	(c)	84.	(c)	85.	(d)	86.	(c)	87.	(b)	88.	(b)	89.	(d)	90.	(b)
91.	(c)	92.	(d)	93.	(b)	94.	(b)	95.	(b)	96.	(a)	97.	(c)	98.	(c)	99.	(a)	100.	(c)
101.	(a,c)	102.	(a)	103.	(a)	104.	(b)	105.	(a)	106.	(c)	107.	(b)	108.	(b)	109.	(d)	110.	(b)

Explanation Theory of Computation

1. (c)

For every NFA there exist an equivalent DFA and vice-versa. Power of both NFA and DFA for recognization of language is same.

2. (d)

$ac \in L(r_1)$, since we can take b^* as $\in$ and c^* as c.
$ac \in L(r_3)$, since $(a + b + c)^*$ includes all combinations of a, b and c.
$ac \notin L(r_2)$ since whenever $(a^* b + c)^*$ is taken to include a, "a is always followed by b".
a^*b = b, ab, aab, ... & so on.

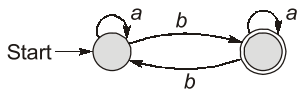
3. (d)

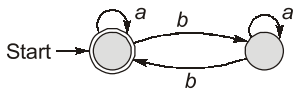
$L(r_1)$ is the set of all string starting with 'a'.
$L(r_2)$ is the set of all starting with 'b'.
Since any word belonging to Σ^* either starts with "a" or starts with "b" or is "$\in$", therefore
$L(r_1) \cup L(r_2) \cup \{\in\} = \Sigma^*$

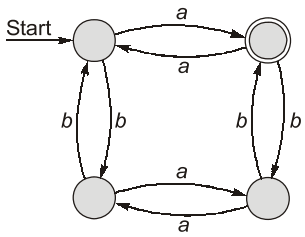
4. (d)

Note that
$(b^*a^*)^* = (a^*b^*)^* = (a^* + b^*)^* = (a + b)^*$ so for (*a*) $L((b^*a^*)^*\ (d^*c^*)^*)$ gives all the combinations of *a* and *b* followed by all the combinations of *c* and *d*.
for (*b*) $L((d^*c^*b^*a^*)^*) = (a + b + c + d)^*$
will generate all strings with combination of *a*, *b*, *c*, *b* and *d*.
for (*c*) $L((a^*b^*a^*c^*d^*)^*) = (a + b + c + d + a^*)^*$
$= (a + b + c + d)^*$

5. (d)

(i)


(ii)


(iii)


As we can construct the DFA for the given languages, hence all of the given languages are regular.

6. (d)

All languages are accepting strings over the alphabet {*a*, *b*} that contains exactly two *a*'s but they are not accepting all strings like the first choice just accepts '*aa*'. The second choice can't accept '*baa*'. The third choice can't accept '*baab*'. The correct regular expression is $b^*\ a\ b^*\ a\ b^*$.

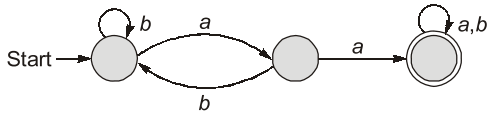
7. (b)

Choice '*a*' is incorrect since it does not include the string "*a*", "*b*" and "∈" (all of which do not end with *ab*).
None of choices '*c*' or '*d*' accept the string '*a*', So they can't represent specified language.

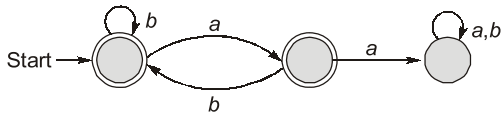
8. (a)

The regular expression corresponding to the language of strings of even lengths over the alphabet of {*a*, *b*} is $((a + b)^2)^*$ which is equivalent to $(aa + bb + ba + ab)^*$. In choice (b) the string '*ab*' is not present. In choice (c) the string '*aa*' is not present. In choice (d) odd length strings are also acceptable.

9. (b)



First draw FSM for accepting all strings containing consecutive a's, as shown above. Now change the final states to non final states and non final states to final states to get the required DFA shown below:



10. (a)

For DFA accepting all the strings with number of *a's* divisible by 4, four states are required similarly for DFA accepting all the strings with number of *b*'*s* divisible by 5, five states are required and for their combination, states will be multiplied.
So 5 × 4 = 20 states will be required.

11. (a)

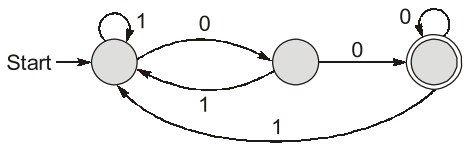
(ii) and (iii) are false since, $x^+\ y^+$ does not necessarily generate equal number of x'*s* and y'*s* and hence are not satisfying the conditions of the given language.

12. (c)

Since $L = X^* = \{0, 1\}^* = (0 + 1)^*$ and
$R = \{0^n 1^n \mid n > 0\}$, $L \cup R$ produces $(0 + 1)^*$ which is regular language and *R* is not regular as there is no regular expression for that *R* is actually DCFL.

13. (b)

The DFA will be



For these kind of problems the required number of states are always equival to "the length of the string that it is ending with" + 1.

CHAPTER 2

Advance Level

Theory of Computation

1. Finite Automata: Regular Languages

Q.1 Which of the following statements are true?

(i) $L(((ab)^*(ba)^*) \cap ((ba)^*(ab)^*)) = \{\epsilon\}$

(ii) $L((ab^*\, ba^*) \cap (ba^*\, ab)) = \{\epsilon\}$

(iii) $L((a^*b^*b)^* \cap (b^*a^*a)^*) = \{\epsilon\}$

(a) (i) and (ii) only (b) (ii) and (iii) only

(c) (i) and (iii) only (d) (iii) only

Q.2 Which of the following statements are true?

(i) $L((a^*b)^* + (ba^*)^*) = \Sigma^*$

(ii) $L((a^*b^*)^* + (b^*a^*)) = \Sigma^*$

(iii) $L((ab)^* + (ba)^*) = \Sigma^*$

(a) (i) only (b) (ii) only

(c) (iii) only (d) None of these

Q.3 If a DFA is represented by the following transition table, then how many states does the corresponding minimal DFA contains?

State	Input	
	0	1
Start → A	B	C
B	B	D
C	B	C
D	B	E
Final → E	B	C

(a) 2 (b) 3

(c) 4 (d) 5

Q.4 Consider $G = \{(a, b), \{S\}, S, \{S \to b \mid Sa \mid aS \mid SS\}\)$ Which of the following are true?

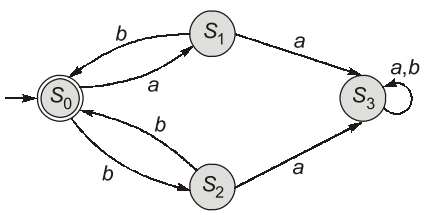
(i) $aabbaa \in G$ (ii) G is ambiguous

(iii) Regular expression corresponding to G is ba^*

(a) (i) and (ii) only (b) (ii) and (iii) only

(c) (i) and (iii) only (d) all of the above

Q.5 Which languages does the following DFA accept?



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

(c) $(ab + ba)^*$ (d) $(aa + bb)^*$

Q.6 Which of the following statements are false?

(a) The regular expression (1 + 10)* denotes all strings of 0's and 1's beginning with '1' and not having two consecutive 0's.

(b) The regular expression (0 + 1)* 011 denotes all strings of 0's and 1's ending with 011.

(c) The regular expression 00(1+10)* denotes all strings of 0's and 1's with atleast two consecutive 0's.

(d) The regular expression $(0 + \epsilon)$ (1+10)* denotes all strings of 0's and 1's that do not have two consecutive 0's.

Q.7 Which of the following statement must always be true for A and B? Suppose A and B are two sets of strings from Σ^*, such that $B \subseteq A$

(i) If A is finite then, B is finite.

(ii) If A is regular then, B is regular.

(iii) If A is context free then, B is context free.

(a) (i) only (b) (ii) only

(c) (iii) only (d) All of them

Q.8 Consider the following grammar G:

$S \to aA$, $A \to (aA, bB)$, $B \to (bB, c, cC)$, $C \to (c, cC)$

Which of the following is $L(G)$?

(a) $L(G) = a^*b^*c^*$ (b) $L(G) = aa^*b^*c^*$

(c) $L(G) = aa^*bb^*cc^*$ (d) $L(G) = (abc)^*$

Q.9 Deterministic finite automata of a language over alphabets {0, 1}, which does not contain 3 consecutive 0's. Minimum how many states, S, in all, the DFA will have and how many of them will be final states, F?

(a) $|S| = 5$ and $|F| = 2$

(b) $|S| = 5$ and $|F| = 3$

(c) $|S| = 4$ and $|F| = 3$

(d) $|S| = 3$ and $|F| = 1$

Q.10 Consider the following regular grammar:

$R_1 = (a + b)^*$

$R_2 = (a^* + b^*)^*$

$R_3 = (\in + a + b^*)^*$

Minimized deterministic finite automata of which R_1, R_2 and R_3 are exactly same except state names?

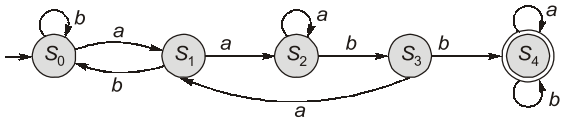
(a) DFA for R_1 and R_2 are similar

(b) DFA for R_2 and R_3 are similar

(c) DFAs of R_1, R_2 and R_3 are different

(d) DFAs of R_1, R_2 and R_3 are similar

Q.11 Consider the following machine M:



What is the language $L(M)$ accepted by this machine?

(a) $L(M)$ = {Set of all words starting with *aabb*}.

(b) $L(M)$ = {Set of all words having *aabb* as a subword}.

(c) $L(M)$ = {Set of all words ending with *aabb*}.

(d) $L(M)$ = {Set of all words with exactly one occurance of *aabb*}.

Q.12 Consider a grammar G as follows:

$S \to aA,\ A \to bbA,\ A \to c$

$L(G)$ = ?

(a) $L(G) = \{abbc\}$

(b) $L(G) = \{ab^n c \mid n \geq 0\}$

(c) $L(G) = \{ab^{2n} c \mid n > 0\}$

(d) $L(G) = \{ab^{2n} c \mid n \geq 0\}$

Q.13 Let $r_1 = (a + b^2)^*$, $r_2 = (a^* + b^*)^*$, $r_3 = (a^2 + b)^*$. Which of the following is true?

(a) $L(r_1) \subseteq L(r_2)$ and $L(r_3) \subseteq L(r_2)$

(b) $L(r_2) \subseteq L(r_1)$ and $L(r_2) \subseteq L(r_3)$

(c) $L(r_1) = L(r_3) \subseteq L(r_2)$

(d) $L(r_1) \cup L(r_3) = L(r_2)$

Q.14 $r_1 = (b^*\, ab^*\, ab^*\, ab^*)^*$, $r_2 = (b^*\, ab^*\, ab^*)^*$. What is $L(r_1) \cap L(r_2)$?

(a) $[(b^*\, ab^*\, ab^*\, ab^*)^*]$

(b) $[(b^*\, ab^*\, ab^*)^*]$

(c) $[(b^*\, ab^*\, ab^*)^6]$

(d) $[(b^*\, ab^*\, ab^*\, ab^*\, ab^*\, ab^*)^*]$

Q.15 Which of the following statement is not correct?

(a) If L is accepted by NFA, then there exists of DFA that accepts L.

(b) If L is accepted by an NFA with $\in$ transition, then L can be accepted by NFA without $\in$ transition.

(c) If L is accepted by a non-deterministic PDA then it is not always true that L is also accepted by deterministic PDA.

(d) If L is accepted by turing Machine, which halts on every w in L then L' is recursively enumerable but not recursive.

Q.16 In a string of length n, how many proper prefixes can be generated

(a) 2^n (b) n

(c) $\dfrac{n(n+1)}{2}$ (d) $n - 1$

Q.17 Consider the grammar:

$S \to aaaS \mid a \mid aa$

$L(G)$ = ?

(a) $L(G) = \{w : |w| \bmod 3 = 0\}$

(b) $L(G) = \{w : |w| \bmod 3 = 1 \text{ or } 2\}$

(c) $L(G) = L(a^*)$

(d) $L(G) = L(a^*) - \{\in\}$

Q.18 Given an arbitrary DFA with 2^N states, what will be the number of states of the corresponding NFA?

(a) $N \times N$ (b) 2^N

(c) $2N$ (d) $N!$

Q.19 The following CFG:

$S \to aB \mid bA$

$A \to a \mid aS \mid bAA$

$B \to b \mid bS \mid aBB$

Generates strings of terminals that have

(a) Equal number of *a*'s and *b*'s

(b) Odd number of *a*'s and even number of *b*'s

(c) Even number of *a*'s and even number of *b*'s

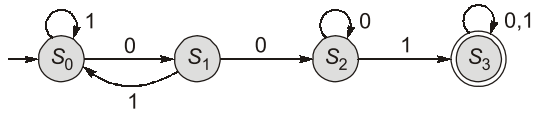
(d) Odd number of *a*'s and even number of *a*'s

Q.20 The regular expression 0*(10*)* denotes the same set as

(a) (1*0)*1* (b) 0 + (0 + 10)*

(c) (0 + 1)*10(0 + 1)* (d) None of these

Q.21 Consider the following deterministic finite state automation M:



Let S denote the set of seven bit binary strings in which the first, the forth and the last bits are 1. The number of strings is S that are accepted by M is

(a) 1 (b) 5
(c) 7 (d) 8

Q.22 If an NDFA accepting L is denoted by (Q, S, d, q_0, F) the equivalence DFA is denoted by $M' = (Q', \Sigma, \delta, q_0', F')$. Which of the following is true?

(a) $Q' \subseteq 2^Q$
(b) $q_0' = q_0$
(c) F' is the set containing all elements of F
(d) None of these

Q.23 An FSM can be used to add two given integers. This remark is

(a) True (b) False
(c) May be true (d) None of these

Q.24 Consider the production grammar

$S \to AB \mid AS,\ A \to a \mid aA,\ B \to b$

Which of the following regular expressions carresponds to the given production grammar?

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

Q.25 P, Q, R are three languages. If P and R are regular and if $PQ = R$, then

(a) Q has to be regular
(b) Q can not be regular
(c) Q need not be regular
(d) Q has to be a CFL

Q.26 If $G = (\{S\}, \{a\}, \{S \to SS\}, S)$, find language generated by G.

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

Q.27 If $w \in (a, b)^*$ satisfies $abw = wab$, then $|w|$ is

(a) Even (b) Odd
(c) Null (d) None of these

Q.28 What is the regular expression for the language generated by $S \to aS \mid bA,\ A \to d \mid ccA$

(a) a^*bd (b) $a^* (bd) (bcc)^* d$
(c) $a^* b(cc)^* d$ (d) None of these

Directions for Question 29 and 30:
Consider the transition table as given below:

δ	0	1	2
(A)	A	B	C
(B)	–	B	C
(C)	–	–	C

Q.29 How many strings ending with 0 will be accepted by the given DFA if the maximum possible length of the string is n.

(a) 0 (b) 1
(c) $n - 1$ (d) n

Q.30 If A becomes a non-accepting state, then how many strings ending with 0 will be accepted if maximum length of string is n.

(a) 0 (b) 1
(c) n (d) $n + 1$

Q.31 Which of the following can be recognized by a DFA?

(a) The number 1,2,4, ... 2^n... written in binary
(b) The number 1, 2, 4,... 2^n... written in unary
(c) The set of binary strings in which the number of 0's is same as the number of 1's
(d) The set {0, 101, 11011, 1110111, ...}

Directions for Question 32, 33 and 34:
Consider the transition table of a DFA as given below:

δ	a	b
Start	q_0	q_4
q_0	q_0	q_1
q_1	q_0	q_2
(q_2)	q_0	q_2
(q_3)	q_3	q_4
q_4	q_3	q_4

Q.32 Which of the following is the most precise interpretation of state q_2?

(a) Accepts strings starting with a and ending with b.
(b) Accepts strings starting with a and ending with ab.
(c) Accepts strings starting with b and ending with a.
(d) Accepts strings starting with a and ending with bb.

Q.33 Which of the following is the most precise interpretation of state q_3?

(a) Accepts strings starting with a and ending with b.
(b) Accepts strings starting with b and ending with bb.
(c) Accepts strings starting with b and ending with ab.
(d) Accepts strings starting with b and ending with a.

Answers Theory of Computation

1.	(d)	2.	(b)	3.	(c)	4.	(a)	5.	(b)	6.	(c)	7.	(a)	8.	(c)	9.	(c)	10.	(d)
11.	(b)	12.	(d)	13.	(a)	14.	(d)	15.	(d)	16.	(b)	17.	(b)	18.	(b)	19.	(a)	20.	(a)
21.	(c)	22.	(a)	23.	(b)	24.	(d)	25.	(c)	26.	(a)	27	(a)	28.	(c)	29.	(d)	30.	(a)
31.	(a)	32.	(d)	33.	(d)	34.	(b)	35.	(b)	36.	(b)	37.	(a)	38.	(d)	39.	(d)	40.	(b)
41.	(c)	42.	(b)	43.	(d)	44.	(c)	45.	(a)	46.	(d)	47.	(d)	48.	(d)	49.	(c)	50.	(c)
51.	(d)	52.	(c)	53.	(a)	54.	(c)	55.	(a)	56.	(c)	57.	(d)	58.	(c)	59.	(d)	60.	(c)
61.	(b)	62.	(a)	63.	(a)	64.	(a)	65.	(a)	66.	(d)	67.	(b)	68.	(c)	69.	(d)	70.	(b)
71.	(b)	72.	(b)	73.	(d)	74.	(b)	75.	(b)	76.	(a)	77.	(d)	78.	(c)	79.	**(d)**	80.	(d)
81.	(b)	82.	(d)	83.	(c)	84.	(c)	85.	(c)	86.	(d)								

Explanation Theory of Computation

1. (d)

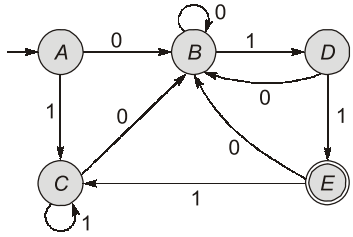
For (i) intersection of $(ab)^*(ba)^*$ and $(ba)^*(ab)^*$ is not $\{\in\}$. For eg. "*ab*" is one more string which satisfies '$\cap$'.
Therefore (i) is false.
For (ii) let $L_1 = (ab^*ba^*)$ and $L_2 = (ba^*ab)$. The string in L_1 should always start with '*a*', where as for L_2 it always starts with '*b*'. $\in$ is not part of either language. Hence intersection is $\{\}$.
Hence (ii) is also false.
For (iii) both $(a^*b^*b)^*$ and $(b^*a^*a)^*$ contain "$\in$".
No other string is common. Because strings in L_1 must end with '*b*', where as strings in L_2 must end with '*a*'.

2. (b)

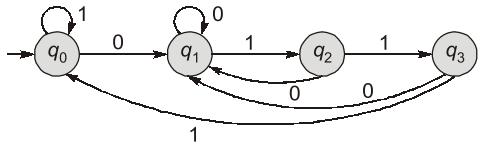
The first one is not Σ^* because '*aa*' is not present in the language *L*. In (ii) all possible strings are present since, $(a^*b^*) = (a^* + b^*)^* = (a + b)^*$. Therefore (ii) is Σ^*. (iii) is not Σ^* because, in (iii) single letter strings '*a*' or '*b*' are not present. Also *abba*, *aa*, *bb*, etc. are also not present.

3. (c)

Drawing the DFA corresponding to the given transition table:



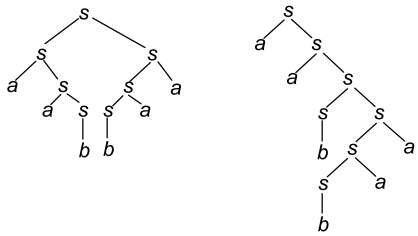
Use DFA minimization algorithm
The corresponding minimum state DFA for this language can be constructed as



Only 4 states are needed.

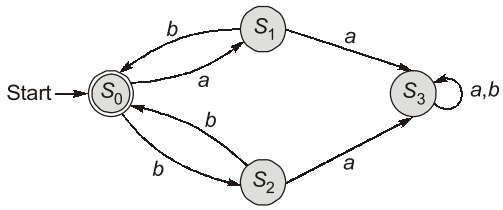
4. (a)

Two derivation trees are possible for *aabba* as given below:



Therefore (i) and (ii) are both true.
Choice (iii): '*aba*' is also accepted by the given grammar. Therefore (iii) is false.

5. (b)



We can clearly see that any number of loops of "*ab*" and "*bb*" can be accepted and '0' is the accepting state.

6. (c)

The given regular expression 00(1 + 10)* is not complete to denotes all strings of 0's and 1's with atleast two consecutive 0's.

The correct regular expression must be

$$(0 + 1)^* 00 (0 + 1)^*$$

7. (a)

It is possible to have a subset of regular language which is not regular and a subset of CFL which is not CFL, but a subset of finite set has to be finite.

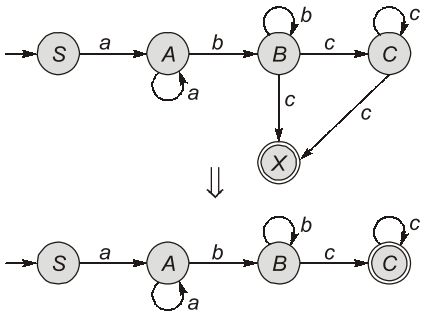
For example:

1. $L = (0 + 1)^*$ is regular.
   Let $L_s = \{0^n 1^n\}$
   Here $L_s \subseteq L$. But L_s is not regular.
2. $L = (0 + 1)^*$ is regular and hence also CFL.
   Consider
   $L_s = \{0^n 1^n 0^n \mid n \geq 0\}$
   Here $L_s \subseteq L$, but L_s is not a CFL.

Hence, (ii) and (iii) are incorrect.

8. (c)

The given grammar is right linear.



The above FA accepts the language

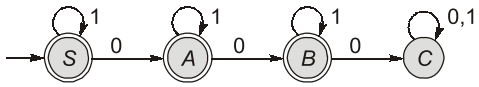
$$L(G) = aa^* bb^* cc^*$$

9. (c)

The regular expresession for the language:

$L = \{W \mid W$ does not contain 3 consecutive 0's$\}$ is

$r = 1^* + 1^* 01^* + 1^* 01^* 01^*$



$\therefore$ Number of state, $|S| = 4$

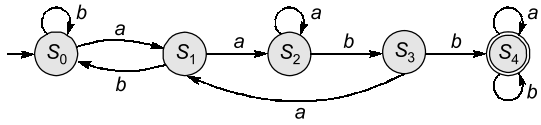
Number of final states, $|F| = 3$

10. (d)

$$R_1 = (a + b)^* \quad ...(1)$$
$$R_2 = (a^* + b^*) = (a + b)^* \quad ...(2)$$
$$R_3 = (\in + a + b)^* = (a + b)^* \quad ...(3)$$

Clearly from (1), (2) and (3).

11. (b)



Clearly, we can observe that the minimum string accepted is *aabb*.

The corresponding $L(M) = \{w \mid w \in (a + b)^* aabb (a + b)^*\}$.

12. (d)

The given grammar *G*:

$S \to aA$, $A \to bbA$, $A \to c$, $A \to bbA \mid c$ generates $\{b^{2n}c, n \geq 0\}$

Then $S \to aA$ generates $\{ab^{2n}c, n \geq 0\}$ then the language corresponding to it is

So, $L(G) = \{ab^{2n}c \mid n \geq 0\}$

13. (a)

$$r_1 = (a + b^2)^* = (a + bb)^* = (a^*(bb)^*)^*$$
$$r_2 = (a^* + b^*)^* = (a + b)^* = (a^* b^*)^*$$
$$r_3 = (a^2 + b)^* = (aa + b)^* = ((aa)^* b^*)$$

$\therefore$ $L(r_1) \subseteq L(r_2)$ and $L(r_3) \subseteq L(r_2)$

14. (d)

$$r_1 = (b^* ab^* ab^* ab^*)^*$$
$$r_2 = (b^* ab^* ab^*)^*$$

r_1 denotes multiple of 3 *a*'s, with any number of *b*'s.

r_2 denotes multiple of 2 *a*'s, with any number of *b*'s. $L(r_1) \cap L(r_2)$ denotes multiple of 6 *a*'s, with any number of *b*'s. Hence,

$$L(r_1) \cap L(r_2) = L[(b^* ab^* ab^* ab^* ab^* ab^*)^*]$$