Techno India Batanagar
Computer Science and Engineering

Model Questions

Subject Name: Formal Language and Automata Theory **Subject Code:** CS 402

Multiple Choice Questions

1. The basic limitation of an FSM is
   i) It cannot remember arbitrary large amount of information
   ii) It sometimes recognizes grammar that is regular
   iii) It sometimes fails to recognize regular grammar
   iv) All of these.
2. Choose the incorrect statement:
   i) Moore and Mealy machines are FSM with output capabilities
   ii) Any given Moore machine has an equivalent Mealy machine
   iii) Any given Mealy machine has an equivalent Moore machine
   iv) Moore machine is not an FSM.
3. The intersection of CFL and regular language
   i) Regular
   ii) CFL
   iii) Both regular and CFL
   iv) None of these.
4. Palindromes cannot be recognized by an FSM because
   i) An FSM cannot remember arbitrary large amount of information
   ii) An FSM cannot deterministically fix the mid-point
   iii) An FSM cannot match the second half of the string with first half
   iv) None of these.
5. Can a DFA simulate an NFA?
   i) Yes, it can
   ii) No, it cannot
   iii) It can do sometimes
   iv) Depends upon the NFA.
6. (P + Q)* = ?
   i) (P* + Q*)
   ii) P* + Q*
   iii) (P* Q*)*
   iv) Both i) and iii).
7. What is the RE for the language set strings with at least one 1, one 2 and one 3?
   i) 1 + 2 + 3
   ii) 11* 22* 33*
   iii) 1* 2 * 3
   iv) Both i) and ii).
8. Which of the following sets are regular?
   i) $\{ a^i \mid i = n^2, n >= 1 \}$
   ii) $\{ a^p \mid p \text{ is prime} \}$
   iii) $\{ ww \mid w \in \{a, b\}^+ \}$
   iv) $\{ a^{2n} \mid n >= 1 \}$
9. The regular expression representing the set of all strings over {X, Y} ending with XX and beginning with Y is
   i) XX (X + Y)* Y
   ii) YY (X + Y)* X
   iii) Y (X + Y)* XX
   iv) Y (XY)* XX.
10. The regular expression (a/b)(a/b) denotes the set
    i) { *a, b, ab, aa* }
    ii) { *a, b, ba, bb* }
    iii) Both i) and ii)
    iv) None of these.
11. Moore machine output depends on
    i) Input

ii) Input and present state
iii) Present state
iv) None of these.

12. FSM can recognize
    i) A grammar depending on the characteristics of FSM
    ii) An CFG
    iii) Any unambiguous grammar
    iv) Only regular grammar.
13. DFA has a transition function
    i) $Q \times \Sigma \rightarrow Q$
    ii) $Q \times \Sigma \rightarrow 2^Q$
    iii) Both i) and ii)
    iv) None of these.
14. The class of CFG is not closed under
    i) Concatenation
    ii) Intersection
    iii) Union
    iv) Repeated Concatenation.
15. Consider the CFG as defined:

    $X \rightarrow XY$
    $X \rightarrow aX / bX / a$
    $Y \rightarrow Ya / Yb / b$

    Any string of terminals, which can be generated by the CFG
    i) Has at least one b
    ii) Ends with a
    iii) Has no consecutive a's and b's
    iv) Has at least 2 a's.
16. A grammar that produces more than one parse tree for the same sentence is called
    i) Contiguous
    ii) Ambiguous
    iii) Unambiguous
    iv) Regular
17. The following production rules of a regular grammar generate a language L:
    $S \rightarrow aS / bS / a / b$
    The regular expression of L is
    i) a + b
    ii) (a + b)*
    iii) (a + b)(a + b)*
    iv) (aa + bb) a*b*.
18. If Q is the number of states of a NFA, the equivalent DFA can have a maximum number of states
    i) Q
    ii) Q - 1
    iii) 2Q - 1
    iv) 2^Q.
19. A Shift Register is
    i) A Mealy machine
    ii) A Moore machine
    iii) A Turing machine
    iv) All of these.
20. A Push Down Automaton is different from a finite automaton because of
    i) A read head
    ii) A memory in the form of a stack
    iii) A set of states
    iv) All of these.
21. The production grammar { $S \rightarrow aSbb$, $S \rightarrow abb$} is
    i) Type 3 grammar
    ii) Type 2 grammar
    iii) Type 1 grammar
    iv) Type 0 grammar.
22. The loop-free testing graph indicates that
    i) The machine has finite memory
    ii) The machine has non-finite memory
    iii) The machine has finite states
    iv) The machine has non-finite states.
23. Consider the following regular expression
    R = (ab + abb)* bbab
    Which of the following is not a set denoted by R?
    i) abababab
    ii) ababbabbbab
    iii) abbbab
    iv) abbabbbab.
24. Which of the following is correct?
    i) A language can be derived from the FA

ii) Regular expressions can be derived from the FA
iii) FA can be derived from the language
iv) Both i) and iii).

25. The reduced grammar of S → AB | a, A → a is
    i) S → a; A → a
    ii) S → a | A ; A → a
    iii) S → a
    iv) S → aa.
26. Which of the following grammars generates strings with any number of 1's?
    i) S → 1A, A → ε
    ii) S → 1S, S → ε
    iii) S → S1, S → ε
    iv) Both ii) and iii).
27. Input sequence of an information lossless machine can be determined from the knowledge of
    i) Only output sequence
    ii) Output sequence and the initial state
    iii) Output sequence, initial state and final state
    iv) Initial state.
28. Context Free Grammar can be recognized by
    i) Finite State Automata
    ii) 2-way Linear Bounded Automata
    iii) Push Down Automata
    iv) Both ii) and iii).
29. A Mealy machine accepts a string of length k; the output string length is
    i) k
    ii) 2k
    iii) k + 1
    iv) k - 1
30. a*(a+b)* is equivalent to
    i) a* + b*
    ii) a*b*
    iii) (ab)*
    iv) None of these
31. Which is true for the transition statement: δ(q, ab)
    i) δ(q, a) ∪ δ(q, b)
    ii) δ(δ(q, a), b)
    iii) δ(δ(q, a), b
    iv) δ(q, a) ∩ δ(q, b)
32. Which of the following statements is incorrect?
    i) A Turing Machine cannot solve Halting problem
    ii) Set of recursively enumerated languages is closed under union
    iii) A FSM with 3 stacks is more powerful than FSM with 2 stacks
    iv) Context sensitive grammar can be recognized by a linearly bounded memory machine.
33. A string after full traversal, if not accepted by an FA, ends up at
    i) Some non-final states
    ii) One of the final states
    iii) One non-final state
    iv) Some non-final states
34. A FA with the same initial and final state
    i) Not possible to define such an FA
    ii) Can produce arbitrary output
    iii) Can accept Null string
    iv) Can accept any input
35. A NFA with ε-transition includes
    i) No transition for an input
    ii) Multiple transitions for an input
    iii) One or more transition without any input
    iv) Transition to a Null state
36. What is true for a dead or sink state
    i) It cannot be reached any time
    ii) There is no necessity of the state
    iii) If the state is reached, there is no way to come out of the state
    iv) None of the above
37. An Incompletely specified FA is defined such as

i) All next states are not mentioned
ii) All outputs are not mentioned
iii) Both of i) and ii)
iv) All inputs are not mentioned

38. Two states are called 1-equivalent if
    i) Both of the states produces the output 1
    ii) Both of the states produces the same output for a string of length 1
    iii) Both of the states produces the same output for any input
    iv) Both of the states produces the same output for input 1
39. Two states are called k-equivalent if
    i) Both of the states are equivalent for all levels above k
    ii) Both of the states are equivalent for all levels from 0 to k-1
    iii) Both of the states have at least k number of states
    iv) Both of the states have exactly k number of states
40. Two states of an Incompletely specified FA are compatible if
    i) Both of the states have identical outputs for same input
    ii) Both of the states have compatible next states for all inputs
    iii) Both of the states have identical output and compatible next states for same input
    iv) None of the above
41. A Moore machine accepts a string of length k; the length of the output string is
    i) k
    ii) 2k
    iii) k + 1
    iv) k - 1
42. Which is true of the following?
    i) Merger Graph is a directed graph
    ii) Compatibility Graph is a directed graph
    iii) Both are directed
    iv) None of these
43. The logic of pumping lemma is a good example of
    i) The pigeon-hole principle
    ii) The Divide and Conquer technique
    iii) Recursion
    iv) Iteration
44. Which of the following strings can be obtained by the language: L = $\{a^i b^{2i} \mid i>=1\}$
    i) aaabbbbbb
    ii) aabbb
    iii) abbabbba
    iv) aaaabbbabb
45. Which of the following production rule is in CNF?
    i) S → aA
    ii) SA → AS
    iii) S → AB
    iv) All of these
46. The solution for the equation R = Q + RP is
    i) R = QP*
    ii) R = Q*P
    iii) P = RQ*
    iv) R = P
47. Consider the following language: L = $\{ a^n b^n c^n d^n \mid n>= 1\}$
    i) CFL but not regular
    ii) CSL but not CFL
    iii) Regular
    iv) Type 0 not Type 1
48. A CFG is not closed under:
    i) Product
    ii) Union
    iii) Complementation
    iv) Kleene Star
49. Compatible Pairs are obtained from
    i) Merger Graph
    ii) Compatibility Graph
    iii) Testing Table

iv) Testing Graph

50. Consider the grammar: S → aSAb | ε; A → bA | ε;
    The grammar generates strings in the form a^ib^j for some i, j >=0. What are the conditions for i & j?
    i) i = j
    ii) j <= 2i
    iii) j >= 2i
    iv) i <= j
51. Let N be an NFA with n states and let M be the minimized DFA with m states recognizing the same language. Which of the following is NECESSARILY true?
    i) $m <= 2^n$
    ii) n <= m
    iii) M has one accept state
    iv) $m = 2^n$
52. The string 1101 does not belong to the set represented by
    i) 110*(0+1)
    ii) 1(0+1)*101
    iii) (10)*(01)*(00+11)*
    iv) (00+(11)*01)*
53. Which of the following is common for both CNF & GNF?
    i) (NT) → (Single T)(String of NT)
    ii) (NT) → (Single of exactly two NT)
    iii) (NT) → (String of NT)
    iv) (NT) → (Single T)
54. The difference between Turing Machine and Two Way FA is in:
    i) Input Tape
    ii) Read Write Head
    iii) Finite Control
    iv) All of these
55. Recursive languages are
    i) Closed under insertion
    ii) Recursively enumerable
    iii) Closed under complementation
    iv) All of these
56. Consider the following languages:
    $L1 = \{w^{w^R} \mid w \in \{0, 1\}^*\}$
    $L2 = (w\# w^R \mid w \in \{0, 1\}^*\}$ (#: Special Symbol)
    $L3 = \{ww \mid w \in \{0, 1\}^*\}$
    Which of the following is true?
    i) L1 is a Deterministic CFL
    ii) L2 is a Deterministic CFL
    iii) L3 is a CFL, but not Deterministic
    iv) L3 is a Deterministic CFL
57. Context Sensitive Grammar can be recognized by
    i) Linear bounded memory machine
    ii) Deterministic push down machine
    iii) Non-deterministic push down machine
    iv) Finite State Machine
58. Let A = (a+b)*a and B = b(a+b)*, then A intersection B will be
    i) (a+b)*ab
    ii) ab(a+b)*
    iii) a(a+b)*b
    iv) b(a+b)*a
59. Which of the following is the most general phase structured grammar?
    i) Regular
    ii) Context Sensitive
    iii) PDA
    iv) None of these
60. Pumping Lemma is generally used to prove
    i) A grammar is regular
    ii) A grammar is not regular
    iii) Two Regular expressions are equal
    iv) None of these
61. Automata is a/an …….. device
    i) Acceptor only
    ii) Acceptor/Rejecter
    iii) Rejecter only
    iv) Generating
62. Which of the following is true for the language $L = \{a^p \mid p \text{ is prime}\}$?
    i) It is Regular
    ii) It is not Regular but Context Free

iii) It is neither Regular nor Context Free
iv) None of the above

63. A Push Down Machine will behave like a Finite State Machine if the stack memory size is:
    i) 0
    ii) 1
    iii) 2
    iv) None of the above
64. Let L = {w : w ∈ {0, 1}*}, where w contains an even number of 1's; the regular expression representing L is
    i) (0*10*1)*
    ii) 0*(10*1*)*0*
    iii) 0*1(10*1)*10*
    iv) Both i) and iii)
65. State which of the following statement is false:
    i) Halting problem of Turing Machine is undecidable
    ii) Determining whether a Context Free Grammar is ambiguous is undecidable
    iii) Given G1 and G2, two arbitrary Context Free Grammars, it is undecidable if L(G1) = L(G2)
    iv) Given G1 and G2, two Regular Grammars, it is undecidable if L(G1) = L(G2)
66. A Language that can be accepted by a Finite Automata, if and only if it is:
    i) Context Sensitive
    ii) Context Free
    iii) Regular
    iv) None of these

67. Every Context Free Grammar can be converted to:
    i) Greibach Normal Form
    ii) Chomsky Normal Form
    iii) Both I & ii
    iv) All of the above

68. The set $\{a^n b^n \mid n>=1\}$ is generated by the CFG:
    i) S → aSb | ab
    ii) S → aSb | ab | ε
    iii) S → aaSbb | ab
    iv) S → aaSbb | aabb | ab
69. Given the grammar S → aSa|bSb|a|b, the language generated is the set of
    i) All palindromes
    ii) Even palindromes
    iii) Odd palindromes
    iv) All of the above
70. The following CFG:
    S → aB | bA
    A → b | aS | bAA
    B → a | bS | aBB
    generates strings that have:
    i) Equal number of a's and b's
    ii) Odd number of a's and odd number of b's
    iii) Even number of a's and even number of b's
    iv) None of the above

71. Let L1 and L2 be two Context Free Languages and R be any regular language. Which of the following is/are correct?

    A. L1 ∪ L2 is Context Free
    B. ~L2 is Context Free
    C. L1 – R is Context Free
    D. L1 ∩ L2 is Context Free
    i) A, B & D only
    ii) A & C only
    iii) B & D only
    iv) A only

72. What is the minimum number of states for a Deterministic Automata that accepts the Regular Language?
    $L = \{w_1 a w_2 \mid w_1, w_2 \in \{a, b\}^*, |w_1|=2, |w_2|>= 3\}$

73. Identify the language generated by the following grammar:
    S → XY; X → aX|a; Y → aYb|ε

i) $\{a^m b^n \mid m>=n, n> 0\}$
ii) $\{a^m b^n \mid m>=n, n>= 0\}$
iii) $\{a^m b^n \mid m>n, n>= 0\}$
iv) $\{a^m b^n \mid m>n, n> 0\}$

74. Consider the following grammar G:

$S \rightarrow E - T|T; T \rightarrow T + F|F; F \rightarrow (E) \mid id$

Which of the following is not Left Recursive but equivalent to G?

i) $S \rightarrow E - T|T; T \rightarrow T + F|F; F \rightarrow (E) \mid id$
ii) $E \rightarrow TE'; E' \rightarrow - TE' \mid \varepsilon; T \rightarrow T + F|F; F \rightarrow (E) \mid id$
iii) $E \rightarrow TX; X \rightarrow - TX \mid \varepsilon; T \rightarrow FY; Y \rightarrow +FY \mid \varepsilon; F \rightarrow (E) \mid id$
iv) $E \rightarrow TX \mid (TX); X \rightarrow - TX|+TX \mid \varepsilon; T \rightarrow id$

75.The Transition Functions for a ε-NFA are:

$\delta(q0, \varepsilon)=q2, \delta(q0, a)=q1, \delta(q0, b)=q0$
$\delta(q1, \varepsilon)=q2, \delta(q1, a)=q2, \delta(q1, b)=q3$
$\delta(q2, \varepsilon)=q2, \delta(q2, a)= \emptyset, \delta(q2, b)= \emptyset$
$\delta(q3, \varepsilon)= \emptyset, \delta(q3, a)= \emptyset, \delta(q3, b)=q2$

If the initial state is q0, then, $\delta(q2, aba)$ is

i) $\{\emptyset\}$
ii) $\{q0, q1, q3\}$
iii) $\{q0, q1, q2\}$
iv) $\{q0, q2, q3\}$

76. Consider the following languages:

$L1 = \{a^p \mid p \text{ is a prime number}\}$
$L2 = \{a^n b^m c^{2m} \mid m, n >= 0\}$
$L3 = \{a^n b^n c^{2n} \mid n >= 0\}$
$L4 = \{a^n b^n \mid n >= 1\}$

Which of the following is/are correct?

A. L1 is Context Free but not Regular
B. L2 is not Context Free
C. L3 is not Context Free but Recursive
D. L4 is Deterministic Context Free

i) A, B & D only
ii) B & C only
iii) A & D only
iv) C & D only

77. Consider the language by the Regular Expression (a+b)*b(a+b). The smallest number of states required by a Deterministic Finite State Automata that accepts the language is?

78. Consider the Grammar, G, with the production rule:

$S \rightarrow SS \mid SaS \mid aSb \mid bSa \mid \varepsilon$

If S is the Start Variable, then which of the following is not generated by G?

i) abab
ii) aaab
iii) abbaa
iv) babba

79. Consider the following grammar G1, G2 with the Production Rules:

G1 : $S \rightarrow aSb \mid T; T \rightarrow cT \mid \varepsilon$
G2 : $S \rightarrow bSa \mid T; T \rightarrow cT \mid \varepsilon$

The language $L(G1) \cap L(G2)$ is ?

i) Finite
ii) Not finite but Regular
iii) Context Free but not Regular
iv) Recursive but not Context Free

80. Consider the following languages:

$L1 = \{a^n b^n c^m \mid m, n >= 0\}$
$L2 = \{a^m b^n c^n \mid m, n >= 0\}$

Which of the following is Context Free?

A. $L1 \cup L2$
B. $L1 \cap L2$

i) A only
ii) B only
iii) Both A & B
iv) None of these

81. Consider the language by the Regular Expression (0+1)*(0+1)(0+1)*. The smallest number of states required by a Deterministic Finite State Automata that accepts the language is?

82. Consider the following grammars:

$S1 \rightarrow aS1b \mid \varepsilon$
$S2 \rightarrow abS2 \mid \varepsilon$

Which of the following is true?

i) L1, L2 are both Regular
ii) L1 is Regular but L2 is not Regular
iii) L2 is Regular but L1 in not Regular
iv) Neither L1 or L2 are Regular

83. Consider the following languages:
L1: Regular, L2: Context-Free,
L3: Recursive and L4: Recursively Enumerable.
Which of the following is/are true?
A. ~L1 ∪ L4 is Recursively Enumerable
B. ~L2 ∪ L3 is Recursive
C. L1* ∩ L2 is Context Free
D. L1 ∪ ~L2 is Context Free
i) A only
ii) A & C only
iii) A & D only
iv) A, B & C only

84. Consider the following languages:
$L1 = \{a^n b^m c^{m+n} \mid m, n >= 1\}$
$L2 = \{a^n b^n c^{2n} \mid n >= 1\}$
Which of the following is Context Free?
i) Both L1 & L2 are Context Free
ii) L1 is Context Free but L2 is not
iii) L2 is Context Free but L1 is not
iv) Neither are Context Free

85. Which of the following grammars are free of left recursion?
i) S → AB; A → Aa|b; B → c
ii) S → Ab|Bb|c; A → Bd|ε; B → e
iii) S → Aa|B; A → Bb|Sc|ε; B →c
iv) S → Ab|Bb|c; A → Bd|ε; B →Ae|ε

86. Consider the Grammar, G, with the production rule:
S → aS | bS | ε
Which of the following is generated by G?
i) $\{a^n b^m \mid m,n >=0\}$
ii) {w ∈ {a, b}*, w has equal number of a's and b's}
iii) $\{a^n \mid n >=0\} \cup \{b^n \mid n >=0\} \cup \{a^n b^n \mid n >=0\}$
iv) {a, b}*

87. Which of the following decision problems are undecidable?
A. Given NFA's N1 and N2, is L(N1) ∩ L(N2) = Ø?
B. Given CFG G = (N, ∑, P, S) and a string w ∈ ∑*, whether w ∈ L(G)?
C. Given CFG's G1 and G2, whether L(G1) = L(G2)?
D. Given a TM M, whether L(M) = Ø?
i) A & D only
ii) B & C only
iii) C & D only
iv) B & D only

88. Which of the following Regular Expressions represent the language – the set of all binary strings having two consecutive 0's and two consecutive 1's?
i) (0+1)*0011(0+1)* + (0+1)*1100(0+1)*
ii) (0+1)*(00(0+1)*11) + (11(0+1)*00)(0+1)*
iii) (0+1)*00(0+1)* + (0+1)*11(0+1)*
iv) 00(0+1)*11 + 11(0+1)*00

89. Consider the following Context Free Grammar, G1 & G2, with the production rules:
G1 : S → aS| B; B → bB| b
G2: S → aA| bB; A → aA| B| ε; B→ bB| ε
Which of the following languages are generated by G1 and G2?
i) $\{a^m b^n \mid m>0$ or $n>0\}$ and $\{a^m b^n \mid m>0$ and $n>0\}$
ii) $\{a^m b^n \mid m>0$ and $n>0\}$ and $\{a^m b^n \mid m>0$ or $n=<0\}$
iii) $\{a^m b^n \mid m>=0$ or $n>0\}$ and $\{a^m b^n \mid m>0$ and $n>0\}$
iv) $\{a^m b^n \mid m>=0$ or $n>0\}$ and $\{a^m b^n \mid m>0$ or $n>0\}$

90. Consider the following PDA with input alphabet ∑ = {a,b}*, states Q = {q0, q1, q2}, q0 being the initial state and {q0,

q2} are final states, stack symbol Γ = {X, Z}, with Z being the initial stack symbol. The Transition Functions are:

δ(q0, a, Z)=(q0, XZ), δ(q0, a, X)=(q0, XX), δ(q0, b, X)=(q1, ε), δ(q1, b, X)=(q1, ε), δ(q1, ε, Z)=(q2, Z)

Let L be the language accepted by the PDA. Which of the following is true?

i) L = $\{a^n b^n \mid n>=0\}$ and is not accepted by any Finite Automata
ii) L = $\{a^n \mid n>=0\} \cup \{a^n b^n \mid n>=0\}$ and is not accepted by a Deterministic PDA
iii) L is not accepted by any Turing Machine that halts on every input
iv) L = $\{a^n \mid n>=0\} \cup \{a^n b^n \mid n>=0\}$ and is Deterministic Context Free

91. X is a Recursive language and Y is a Recursively Enumerable but not recursive language. Let W and Z be two languages such that Y reduces to W and Z reduces to X. Which of the following is true?

i) W can be Recursively Enumerable and Z is Recursive
ii) W can be Recursive and Z is Recursively Enumerable
iii) W is not Recursively Enumerable and Z is Recursive
iv) W is not Recursively Enumerable and Z is not Recursive

92. Which of these languages is Context Free?

L1 = $\{a^m b^n a^n b^m \mid m, n >0\}$
L2 = $\{a^m b^n a^m b^n \mid m, n >0\}$
L3 = $\{a^m b^n \mid m=2n+1\}$

Which of the following is generated by G?

i) L1 and L2 only
ii) L2 and L3 only
iii) L1 and L3 only
iv) L3 only

93. Let L be the language represented by the Regular Expression ∑*0011∑* where ∑ = {0, 1}. What is the minimum number of states in a DFA that recognizes ~L (complement of L)?

i) 4
ii) 5
iii) 6
iv) 8

94. Language L1 is polynomial time reducible to L2. Language L3 is polynomial time reducible to L2, which in turn is polynomial time reducible to L4. Which of the following is true?

A. If L4 ∈ P, then L2 ∈ P
B. If L1 ∈ P and L3 ∈ P, then L2 ∈ P
C. L1 ∈ P if and only if L3 ∈ P
D. If L4 ∈ P, then L1 ∈ P and L3 ∈ P

i) B only
ii) C only
iii) A & D only
iv) A only

95. Which of the following is true?

A. The complement of every Turing decidable language is Turing decidable
B. There exists some language in NP which is not Turing decidable
C. If L is an language in NP, it is Turing decidable

i) Only B
ii) Only C
iii) Only A & B
iv) Only A &C

96. Which of these languages is Regular?

L1 = $\{wxw^R \mid w, x \in \{a, b\}^*, |w| \& |x|>0\}$, w^R is the reverse of string w,
L2 = $\{a^m b^n \mid m \neq m, m, n >= 0\}$
L3 = $\{a^p b^q c^r \mid p, q, r >=0\}$

i) L1 and L3 only
ii) L2 and L3 only
iii) L1 only

iv) L3 only

97. Let X_1, X_2, X_3 be strings with the alphabet $\sum \in \{0, 1\}^*$. They are related as follows:

$X_1 = 1X_2$

$X_2 = 0X_2 + 1X_3$

$X_3 = 0X_2 + \varepsilon$

Which of the following choices precisely represent the string in X_1?

i) $10(0^* + (10)^*)1$
ii) $10(0^* + (10)^*)^*1$
iii) $1(0 + 10)^*1$
iv) $10(0^* + (10)^*)^*1 + 110(0 + 10)^*1$

98. Let L be the language represented by the Regular Expression (0+1)*(10). What is the number of states in a minimal DFA that recognizes L?

99. Let L1 be a Context Free Language and L2 be a Recursively Enumerable but not recursive language. Which of the following is/are necessarily true?

A. ~L1 (complement of L1) is recursive
B. ~L2 (complement of L2) is recursive
C. ~L1 is Context Free
D. ~L1 ∪ L2 is recursively enumerable

i) A only
ii) C only
iii) C & D only
iv) A & D only

100. The Transition Functions for DFA M & N are given below:

M: $\delta(q0, b)=q0$, $\delta(q0, a)=q1$, $\delta(q1, a)=q1$, $\delta(q1, b)=q0$

M: $\delta(q0, a)=q0$, $\delta(q0, b)=q1$, $\delta(q1, b)=q1$, $\delta(q1, a)=q0$

where q0 is the initial state and q1 is the final state for both DFA. The number of states for a minimal DFA that accepts $L(M) \cap L(N)$ is?

101. Consider the following PDA with input alphabet $\sum = \{0,1\}$, states $Q = \{q0, q1, q2\}$, q0 the initial state and {q2} final state, stack alphabet $\Gamma = \{0, 1, Z\}$, with Z being the initial stack symbol. The Transition Functions are:

$\delta(q0, 0, Z)=(q0, 0Z)$, $\delta(q0, 1, Z)=(q0, 1Z)$,
$\delta(q0, 0/1/\varepsilon, Z)=(q1, Z)$,
$\delta(q1, 0, 1)=(q1, \varepsilon)$, $\delta(q1, 1, 0)=(q1, \varepsilon)$,
$\delta(q1, \varepsilon, Z)=(q2, \varepsilon)$

Which of the following strings must follow 101100 such that the overall string is accepted by the automaton?

i) 10110
ii) 10010
iii) 01010
iv) 01001

102. Which of the following problems is/are undecidable?

i) Deciding if a CFG is ambiguous
ii) Deciding if a given string is generated by a given CFG
iii) Deciding if the language generated by a given CFG is empty
iv) Deciding if the language generated by a given CFG is finite

103. Consider the following languages over alphabet $\sum \in \{0, 1, c\}$.

$L1 = \{wcw^R\}$, w^R is the reverse of string w

$L2 = \{ww^R\}$

$L3 = \{0^n1^n \mid n >=0\}$

Which of the languages are Deterministic Context Free languages?

i) None of these
ii) L3 only
iii) L1 & L3 only
iv) All of them

104. Length of the shortest string ($\sum \in \{a, b\}$) NOT in the following Regular Expression is ___:

a*b*(ba)*a*

105. If $L1 = \{a^n \mid n>=0\}$ and $L2 = \{b^n \mid n >= 0\}$, then consider

A. L1.L2 is a Regular Language
B. $L1.L2 = \{a^n b^n \mid n>=0\}$

Which of the following is CORRECT?

i) A only
ii) B only
iii) Both A & B
iv) None of these

106. Language A $\leq_m$ B denotes that language A is mapping reducible to language B. Which of the following is FALSE?

i) If A $\leq_m$ B and B is recursive then A is recursive
ii) If A $\leq_m$ B and B is undecidable then A is undecidable
iii) If A $\leq_m$ B and B is recursively enumerable then A is recursively enumerable
iv) If A $\leq_m$ B and B is not recursively enumerable then A is not recursively enumerable

107. If L1 = {w ∈ {0, 1}* | w has at least as many occurrences of (110)'s as (011)'s} and L2 = {w ∈ {0, 1}* | w has at least as many occurrences of (000)'s as (111)'s}, then which of the following is Correct?

i) L1 is regular but not L2
ii) L2 is regular but not L1
iii) Both of them are regular
iv) None of them are regular

108. Which of the following is true?

i) Language L = {a^n b^n | n>=0} is regular
ii) Language L = {a^p | p is a prime number} is regular
iii) Language L = {w | w has 3k+1 b's, where k ∈ N and w ∈ {a, b} } is regular

Language L = {ww | w ∈ {0, 1} } is regular