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Sample Paper
FINALTERM EXAMINATION
Fall 2022
CS402 - Theory of Automata

Time: 90 min
Marks: 60

Answers:

Question No: 1 - Answer: A. It is a non-null string

Question No: 2 - Answer: A. L partitions ∑ * into distinct classes

Question No: 3 - Answer: D. (L1 ∪ L2) c = (L1 c) ∩ (L2 c) c

Question No: 4 - Answer: D. At least n states

Question No: 5 - Answer: D. Transition graph

Question No: 6 - Answer: B. Mealy machine

Question No: 7 - Answer: C. 01101110

Question No: 8 - Answer: A. Addition of binary numbers

Question No: 9 - Answer: B. Subtraction of binary numbers

Question No: 10 - Answer: A. They print the same output string

Question No: 11 - Answer: A. It is ignored

Question No: 12 - Answer: B. A language that cannot be expressed by any regular expression

Question No: 13 - Answer: A. To prove that a language is non-regular

Question No: 14 - Answer: A. a(a+b)*b

Question No: 15 - Answer: B. Undecidable

Question No: 16 - Answer: C. Regular

Question No: 17 - Answer: C. equal to

Question No: 18 - Answer: C. Infinite non-regular

Question No: 19 - Answer: B. Pre Terminal

Question No: 20 - Answer: D. abababb

Question No: 21 - Answer: B. v(u+v)*u

Question No: 22 - Answer: A. Begin with q and ends with p

Question No: 23 - Answer: B. Null production is not exist in the Chomsky Normal Form

Question No: 24 - Answer: D. 72

Question No: 25 - Answer: B. 0011

Question No: 26 - Answer: D. regular

Question No: 27 - Answer: C. S → 00|^, X → ^

Question No: 28 - Answer: C. ACCEPT, REJECT

Question No: 29 - Answer: C. Descendant

Question No: 30 - Answer: B. A->XY

Question No: 31 - Answer: B. Program

Question No: 32 - Answer: C. DELETE

Question No: 33 - Answer: B. Two

Question No: 34 - Answer: A. a*

Question No: 35 - Answer: D. (a+b)*

Question No: 36 - Answer: B. POP

Question No: 37 - Answer: A. Σ

Question No: 38 - Answer: C. POP

Question No: 39 - Answer: A. #

Question No: 40 - Answer: B. Unit

Question No: 1 (Marks: 01) - Please choose the correct option

What is “y” in pumping lemma version 1?
A. It is a non-null string
B. It is a null-able string
C. It is a non-null string with initial state
D. It is a null-able string with initial state

Question No: 2 (Marks: 01) - Please choose the correct option

Which of the following is true about Myhill Nerode Theorem.
A. L partitions ∑ * into distinct classes
B. L partitions ∑ * into same classes
C. L partitions ∑ * into distinct functions
D. L partitions ∑ * into same functions

Question No: 3 (Marks: 01) - Please choose the correct option

Using De-Morgan's law for sets, which of the following is correct for L1 and L2
A. $(L1^c \cup L2^c)^c = (L1^c)^c \cap (L2^c)^c$
B. $(L1^c \cup L2^c) = (L1^c)^c \cap (L2^c)^c$
C. $(L1^c \cup L2^c)^c = (L1^c) \cap (L2^c)$
D. $(L1 \cup L2)^c = (L1^c)^c \cap (L2^c)^c$

Question No: 4 (Marks: 01) - Please choose the correct option

What is the minimum number of states an FA must have to recognize a language L if there are n distinguishable strings in Σ*?
A. Less than n states
B. Exactly n states
C. More than n states
D. At least n states

Question No: 5 (Marks: 01) - Please choose the correct option

Which of the following machine do not have an ability to accept a Language?
A. Moore machine
B. Finite automata

C. Non-deterministic Finite automata
D. Transition graph

Question No: 6 (Marks: 01) - Please choose the correct option

---

Which of the following is used to make an incrementing machine?
A. Moore machine
B. Mealy machine
C. Finite automata
D. Turing machine

Question No: 7 (Marks: 01) - Please choose the correct option

---

What is the 1's complement of 10101100?
A. 10101000
B. 00101000
C. 01101110
D. 01010011

Question No: 8 (Marks: 01) - Please choose the correct option

---

What is the purpose of an incrementing machine?
A. Addition of binary numbers
B. Subtraction of binary numbers
C. Multiplication of binary numbers
D. Division of binary numbers

Question No: 9 (Marks: 01) - Please choose the correct option

---

What can be built using a complementing machine and an incrementing machine?
A. Addition of binary numbers
B. Subtraction of binary numbers
C. Multiplication of binary numbers
D. Division of binary numbers

Question No: 10 (Marks: 01) - Please choose the correct option

---

Moore and Mealy machines are said to be equivalent for an input string if:
A. They print the same output string
B. They have the different output string
C. They have the same transition table
D. They have the same transition diagram

Question No: 11 (Marks: 01) - Please choose the correct option

---

What happens to the output character of a state if there is no incoming transition at that state in a Mealy machine?

A. It is ignored
B. It is printed
C. It is converted to a Moore machine
D. It is converted to a loop

Question No: 12 (Marks: 01) - Please choose the correct option

---

Which of the following is true about non regular language?

A. A language that can be expressed by a regular expression
B. A language that cannot be expressed by any regular expression
C. A language that can only be expressed by a finite automaton
D. A language that can only be expressed by a Mealy machine

Question No: 13 (Marks: 01) - Please choose the correct option

---

What is the purpose of Pumping Lemma?

A. To prove that a language is non regular
B. To prove that a language is regular
C. To prove that a language is finite regular
D. To prove that a language is infinite regular

Question No: 14 (Marks: 01) - Please choose the correct option

---

Which of the following language is regular?

A. a(a+b)*b
B. $a^n b^n$
C. $a^n b^n c^n$
D. $a^n b^n c^n d^n$

Question No: 15 (Marks: 01) - Please choose the correct option

---

If a problem have no decision procedure, then that problem is called _____ problem.

A. Decidable
B. Undecidable
C. Regular
D. Infinite

Question No: 16 (Marks: 01) - Please choose the correct option

---

If X is a regular language, and Y is any language (regular/non-regular), then Pref(Y in X) is a _____ language.

A. Non defined
B. Non-regular
C. regular
D. non-existing

Question No: 17 (Marks: 01) - Please choose the correct option

---

To test whether FA accepts any word, we have to test at least one word of length that is _____ to its total number of states. If one word will be accepted, then FA accepts a word.

A. less than
B. greater than
C. equal to
D. not equal to

Question No: 18 (Marks: 01) - Please choose the correct option

---

Consider an FA having X states and a word w. If the FA accepts a word w, such that:
X ≤ length (w) < 2X, then FA accepts _____ language.

A. Finite regular
B. Finite non-regular
C. Infinite non-regular
D. Infinite regular

Question No: 19 (Marks: 01) - Please choose the correct option

---

Which of the following is Not a part of a Context Free Grammar?

A. Non-terminal
B. Pre Terminal
C. Production
D. Terminal

Question No: 20 (Marks: 01) - Please choose the correct option

---

Which of the following word is accepted by the following CFG?
S---→ abSb | aS | bS | a | b | ^

A. abbabba
B. aaaabbb
C. bbbbaaa
D. abababb

Question No: 21 (Marks: 01) - Please choose the correct option

Select the correct regular expression corresponding to the following CFG.
Σ = {u, v}
S--→uS|vS|u|v|^

A. $u(u+v)^*v$
B. $v(u+v)^*u$
C. $vu(u+v)^*$
D. $(u+v)^*$

Question No: 22 (Marks: 01) - Please choose the correct option

Consider the following CFG:
S → pZq|qZp
Z → pZ|qZ|Λ
The above CFG accept the language that _____.

A. Begin with q and ends with p
B. Begin and ends with same letters
C. Begin and ends with different letters
D. Begin with p and ends with q

Question No: 23 (Marks: 01) - Please choose the correct option

Which of the following is Not true about Chomsky Normal Form?
A. Unit production exist in the Chomsky Normal Form
B. Null production is not exist in the Chomsky Normal Form
C. Two non-terminals exist at the left side of production in Chomsky Normal Form
D. Only one terminal exist at the right side of production in Chomsky Normal Form

Question No: 24 (Marks: 01) - Please choose the correct option

Which of the following is the correct final result of the following expression:
*+*7512
A. 15
B. 71
C. 38
D. 72

Question No: 25 (Marks: 01) - Please choose the correct option

Consider the following CFG and identify a semiword from the given options.

S → XX|00|11|0|1|^

A. 00
B. 0011
C. 0011X
D. 11

Question No: 26 (Marks: 01) - Please choose the correct option

---

If we have a CFG, in which all the productions are in this form:
Nonterminal------→ semiword
Nonterminal------→ word
Then the language that is accepted by such CFG, will be _____ language.

A. Non-regular
B. Infinite non-regular
C. Finite non-regular
D. regular

Question No: 27 (Marks: 01) - Please choose the correct option

---

Consider the following CFG and remove the unit production from it, then select the correct option which has the correct updated CFG.
S → X|00|^
X → 0 | ^

A. S → X|00, X → 0
B. S → X|^, X → ^
C. S → 00|^, X → ^
D. S → 0|00|^, X → 0 | ^

Question No: 28 (Marks: 01) - Please choose the correct option

---

Halt states in PDA can be:
A. START, PUSH
B. PUSH, REJECT
C. ACCEPT, REJECT
D. READ, POP

Question No: 29 (Marks: 01) - Please choose the correct option

---

Non-terminal is called self-embedded if it occurs in a tree as a:
A. Root

B. Leaf
C. Descendant
D. Edge

Question No: 30 (Marks: 01) - Please choose the correct option

Which of the following is dead production:
A. X->a
B. A->XY
C. Y->AB
D. S->AX

Question No: 31 (Marks: 01) - Please choose the correct option

_____ is a set of rules showing which state is to be entered when a letter is read form the TAPE and what character is to be printed in a Turing Machine.
A. Terminals
B. Program
C. Non-terminals
D. Tape Head

Question No: 32 (Marks: 01) - Please choose the correct option

_____ subprogram removes the character at any location on a TAPE.
A. INSERT
B. UPDATE
C. DELETE
D. SUM

Question No: 33 (Marks: 01) - Please choose the correct option

IN CNF, there must be_____ non terminals at the right side of the production.
A. One
B. Two
C. Three
D. Four

Question No: 34 (Marks: 01) - Please choose the correct option

Following CFG accepts the regular expression:
S-> aS | a
A. a*
B. a^+
C. (a+b)

D. (a+b)*

Question No: 35 (Marks: 01) - Please choose the correct option

---

Following CFG accepts the regular expression:
S-> aS | bS| NULL
A. a*
B. b*
C. a+b
D. (a+b)*

Question No: 36 (Marks: 01) - Please choose the correct option

---

_____ operation takes letter out of stack.
A. PUSH
B. POP
C. INSERT
D. UPDATE

Question No: 37 (Marks: 01) - Please choose the correct option

---

In PDA, the input letters are represented by the symbol:
A. Σ
B. Γ
C. *
D. +

Question No: 38 (Marks: 01) - Please choose the correct option

---

In conversion form of PDA, every READ or HERE is followed immediately by _____ state:
A. PUSH
B. READ
C. POP
D. ACCEPT

Question No: 39 (Marks: 01) - Please choose the correct option

---

The bottom of STACK is represented by a symbol:
A. #

B. $
C. &
D. *

Question No: 40 (Marks: 01) - Please choose the correct option

---

The productions of the form nonterminal → one nonterminal, is called _____ production.
A. Null
B. Unit
C. Nullable
D. Unproductive

Question No: 41 (Marks: 03)

Construct CFG for the regular expression a $(a+b)^+$.

Answer

The regular expression is: a (a+b)+

CFG for the given regular expression is:
S -> aX
X -> aX | bX | ε

Explanation:

The start symbol S generates an 'a' and then non-deterministically goes to X.
X can generate an 'a', or 'b', or an empty string (ε).
This CFG will produce strings in the form "a" followed by one or more occurrences of either 'a' or 'b'.

Question No: 42 (Marks: 03)

Convert the following CFG into CNF.
S-> aX | bX
X-> a
Answer

Steps to convert the CFG into CNF:

Eliminate the ε-production (if any):
There are no ε-productions in the given CFG.

Eliminate the unit productions:
There are no unit productions in the given CFG.

Eliminate the useless symbols:
All the symbols are useful in the given CFG.

Convert the remaining productions into CNF:
S -> aX | bX | a | b
X -> a

Now the CFG is in Chomsky Normal Form (CNF). In CNF, each production is either of the form A -> BC or A -> a, where A, B, and C are non-terminal symbols, and 'a' is a terminal symbol. The given CFG satisfies this condition, so it is already in CNF.

Question No: 43 (Marks: 03)

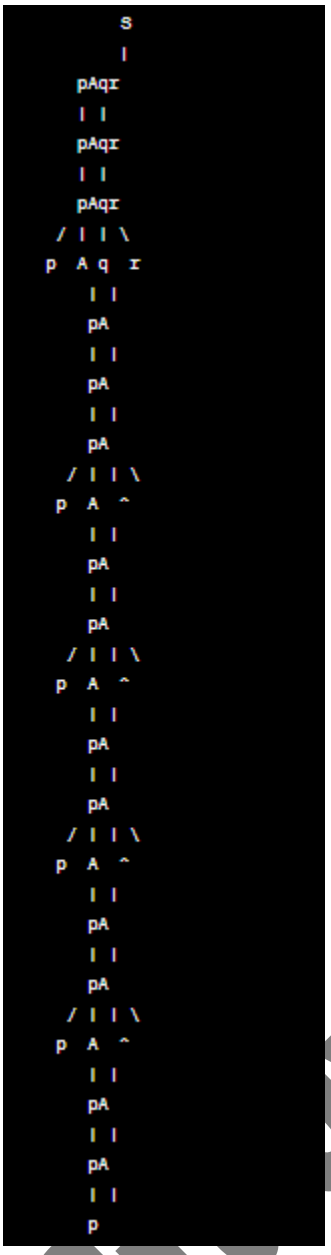
Consider the following CFG:

S--→ pAqr

A--→pA| qA| ^

Draw the derivation tree for the string “ppqppqr”.

Answer



Question No: 44 (Marks: 03)

Consider the following CFG:

S--→ 1A01

A--→0A| 1A| ^

You are required to mention that whether the following strings are accepted by the above CFG:

a) 100001010
b) 011101111
c) 100011101

Answer

b) 011101111
c) 100011101

Question No: 45 (Marks: 03) - Please choose the correct option

Does pumping lemma version 1 helps in determining whether a language is regular or not? Why pumping lemma version 2 is required in determining whether a language is regular or not?

Answer

Pumping Lemma version 1 does not determine if a language is regular. It provides a property for regular languages, but some non-regular languages may also satisfy it. Pumping Lemma version 2 is needed to prove a language is not regular, offering stronger conditions. It effectively shows non-regularity, while version 1 only shows non-conformance to regularity.

Question No: 46 (Marks: 03) - Please choose the correct option

Consider the two TGs, TG1 and TG2. Write the procedure to make TG3 which can accept L1+L2 generated by TG1 and TG2. No need to make diagram.

Answer

To construct TG3 that can accept the union of languages L1 and L2 generated by TG1 and TG2, follow these steps:

1. Start with a new TG3, which will accept L1 + L2, the union of languages L1 and L2.

2. Introduce a new start state S3 in TG3. Add an epsilon transition (ε) from S3 to the start states of TG1 and TG2.

3. Copy the states and transitions of TG1 and TG2 into TG3. Ensure that all accepting states of TG1 and TG2 become accepting states in TG3.

4. Now, TG3 has both TG1 and TG2 combined, accepting L1 + L2. The epsilon transition from S3 allows the TG to start from either TG1 or TG2 and accept strings from both languages.

With these steps, TG3 can accept the union of languages L1 and L2 generated by TG1 and TG2.

Question No: 47 (Marks: 05)

Draw the Turing machine for the regular language expressed by the regular expression (a+b)* b (a+b)*.

Answer

Current State	Input Symbol	Write Symbol	Move Direction	Next State
q0	a, b	-	R	q0
q0	b	-	R	q1
q1	a, b	-	R	q2
q2	a, b	-	R	q2
q2	B	-	L	q3
q3	a, b, B	-	L	q3
q3	-	-	R	q4

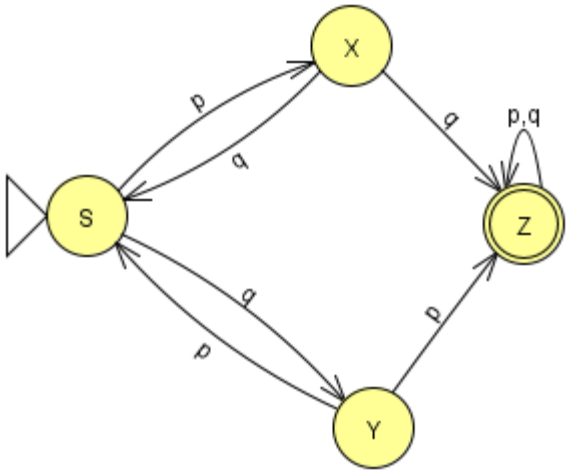
Explanation:

- The Turing machine starts in state q0 and scans the input from left to right.
- In state q0, it keeps moving right until it finds a 'b'.
- Upon finding the 'b', it transitions to state q1 and moves right to skip the rest of the string.
- In state q2, it moves right again to find the end of the string.
- Once it reaches the end of the string, it writes a blank symbol (B) and moves left to start the backtracking process.
- In state q3, it keeps moving left until it finds the first 'b'.
- Upon finding the 'b', it moves right to state q4, which is the accepting state.

Note: The input alphabet consists of 'a', 'b', and a blank symbol 'B'. The blank symbol is used to mark the end of the input string. Also, the Turing machine's head starts on the leftmost non-blank symbol of the input string. The transitions not explicitly mentioned in the table are assumed to lead to a non-accepting (rejecting) state.

Question No: 48 (Marks: 05)

Write the corresponding Context Free Grammar for the given Transition Graph (TG).



Answer

To construct the Context-Free Grammar (CFG) for the given Transition Graph (TG), we need to define the non-terminals, terminals, and production rules based on the transitions in the graph. Let's represent the non-terminals as uppercase letters and the terminals as lowercase letters or symbols. The initial state is denoted by 'S'.

Based on the given TG, the CFG can be represented as follows:

Non-terminals:
S - initial state
X - state with transitions 'P' and 'q' from S
Y - state with transitions 'q' and 'p' from S
Z - final state

Terminals:
P, q, p - transition symbols

Production rules:

1. S -> P X | q X | q Y
   This rule describes the transitions from the initial state S to either X with 'P' or 'q', or to Y with 'q'.

2. X -> q Z
This rule describes the transition from state X to final state Z with 'q'.

3. Y -> q S | p Z
This rule describes the transitions from state Y to either the initial state S with 'q', or to the final state Z with 'p'.

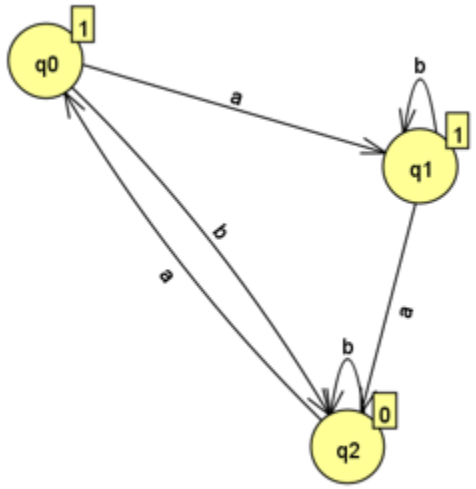
4. Z -> p Z | q Z
This rule allows state Z to loop back on itself with 'p' or 'q'.

These production rules capture the transitions and loops defined in the given TG. The grammar will generate strings based on these rules that follow the paths in the TG starting from the initial state 'S'.

Question No: 49 (Marks: 05) - Please choose the correct option

---

Consider the following Moore machine having:



The states q0, q1, q2 where q0 is the start state
Σ = {a,b},
Γ={0,1}
Run the string “aabbabbab” on the above Moore machine and write the output string against the given input.

Answer

---

the output string corresponding to the input "aabbabbab" on the given Moore machine is: 011000.

Question No: 50 (Marks: 05) - Please choose the correct option

---

Consider Myhill Nerode Theorem to define the classes and make FA of the following:
Language L of strings, defined over ∑ = {a,b}, containing tripple "a".

Answer

In order to apply the Myhill-Nerode theorem to define the classes and construct a finite automaton (FA) for the language L, we need to determine the set of equivalence classes of strings with respect to the indistinguishability relation.

Language L of strings, defined over ∑ = {a, b}, containing the triple "a" means that the language contains strings that have three consecutive occurrences of the symbol "a". For example, "aaabc", "aabaa", "baaab", etc., are all valid strings in the language L.

Let's define the equivalence relation ≡L on the strings over ∑ as follows:
For any two strings x and y in ∑*, x ≡L y if and only if, for any string z in ∑*, the concatenation xz is in L if and only if the concatenation yz is in L.

Using this equivalence relation, we can determine the set of equivalence classes. Each equivalence class will correspond to a state in the FA.

Now, let's determine the equivalence classes for the language L:

1. Equivalence class [ε] (the empty string):
The empty string ε cannot be a part of L since it does not contain the triple "a". So, [ε] = {ε}.

2. Equivalence class [a]:
For any string z in ∑*, the concatenation az will have the triple "a" if z has two consecutive "a"s. So, [a] = {a, aa, aaa, ...}.

3. Equivalence class [b]:

For any string z in ∑*, the concatenation bz will never have the triple "a" since there are no "a"s in bz. So, [b] = {b, bb, bbb, ...}.

The FA for the language L will have three states corresponding to the equivalence classes [ε], [a], and [b]. The transitions will be as follows:

State 1: [ε]
- On input 'a', it stays in the same state (ε is not part of L).
- On input 'b', it transitions to state [b].

State 2: [a]
- On input 'a', it transitions to state [a] (continuing the triple "a").
- On input 'b', it transitions to state [b].

State 3: [b]
- On input 'a', it transitions to state [a] (starting a new triple "a").
- On input 'b', it stays in the same state (b is not part of L).

The FA will have a start state corresponding to the equivalence class [ε] and a final state corresponding to the equivalence class [a] (since we want to recognize strings that end with the triple "a").

Please note that the FA might not be minimal, but it correctly recognizes the language L containing the triple "a".

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