

B Tech II 4th Sem End Sem Exam CS 208

Automata and Formal Languages (AFL) May 2021

5 May 2021 (2:00 pm to 3:00 pm)

There are 60 number of questions. The duration for the quiz is one hour.

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* Required

Comparing TM and computers we find *

- ☒ Computers have more computational power
- ☐ TM has more computational power
- ☐ Both are equivalent
- ☐ They cannot be compared

Decidability in Decidable and Undecidable problems refers to *

- ☐ Unsolvability
- ☐ Existence of algorithm which generates the set of solutions
- ☒ Existence of algorithm which takes an instance of the problem and determines whether the answer to that instance is yes or no
- ☐ Those problems whose answers are only either in yes or no



*

Find a CFG for $\{ w \mid w \text{ is odd and its middle symbol is } 0 \}$

☐ a) $S \rightarrow 0 \mid 1 \mid 0S0 \mid 0S1$

$S \rightarrow 0A \mid 1A$
 $A \rightarrow 0S \mid \epsilon$

☐ b)

☒ c) $S \rightarrow 0 \mid 0S0 \mid 0S1 \mid 1S0 \mid 1S1$

$S \rightarrow 0AS \mid 0A1S \mid A$
 $A \rightarrow 0 \mid 0S \mid 10S$

☐ d)

The class of TMs is equivalent to the class of *

☒ Type 0 Grammars

☐ Type 1 Grammars

☐ Type 2 Grammars

☐ Type 3 Grammars



*

Which of the following is FALSE with respect to possible outcomes of executing a Turing Machine over a given input?

- ☐ a) It may halt and accept the input
- ☒ b) It may halt by changing the input
- ☐ c) It may halt and reject the input
- ☐ d) It may never halt

Write correct option from (a, b, c, d) *

Context free grammar which generates $\{a^l b^m c^n \mid l+m = n\}$ has its production rules given by

- (a) $S \rightarrow bSc \mid aSc \mid ac \mid a \mid bS_1, S_1 \rightarrow S_1c \mid c$
- (b) $S \rightarrow aSc \mid ac \mid bc \mid bS_1c, S_1 \rightarrow bS_1c \mid bc$
- (c) $S \rightarrow cSb, cS \rightarrow Sc, bS \rightarrow Sb, S \rightarrow aS_1c, S_1 \rightarrow aS_1c, S_1 \rightarrow ac$
- (d) $S \rightarrow aS, S \rightarrow aS_1, S_1 \rightarrow bS_1, S_1 \rightarrow bS_2, S_2 \rightarrow bS_3, S_3 \rightarrow cS_3 \mid c$

b

Pushdown automata can recognize *

- ☒ all regular languages, some nonregular languages, all context-free languages
- ☐ all regular languages, all nonregular languages, all context-free languages
- ☐ all regular languages, some nonregular languages, all context-free languages and some non-context-free languages
- ☐ all regular languages, some nonregular languages, all context-free languages and all non-context-free languages



*

Which of the following is true?

- (A) The language $L = \{a^n b^n \mid n \geq 0\}$ is regular.
- (B) The language $L = \{a^n \mid n \text{ is prime}\}$ is regular.
- (C) The language $L = \{w \mid w \text{ has } 3k + 1 \text{ b's for some } k \in \mathbb{N} \text{ with } \Sigma = \{a, b\}\}$ is regular.
- (D) The language $L = \{ww \mid w \in \Sigma^* \text{ with } \Sigma = \{0,1\}\}$ is regular.

- ☐ a) A
- ☐ b) B
- ☒ c) C
- ☐ d) D
- ☐ e) None of these

*

Which of the following statement/s states that Input string is accepted in Pushdown Automata (PDA):

- S1: When the final state is reached in PDA.
- S2: When the stack has any input symbol in it.
- S3: When the stack is empty.

- ☐ a) S1 only
- ☐ b) S2 and S3 only
- ☐ c) S2 and S1 only
- ☒ d) S1 and S3 only



Write correct option from (a, b, c, d) *

Pick the correct statement. The logic of pumping lemma is a good example of

- (a) the pigeon hole principle
- (b) the divide and conquer technique
- (c) recursion
- (d) iteration

a

CFG is not closed under *

- ☐ union
- ☐ Kleene star
- ☒ complement
- ☐ product

Set of all Turing machines is *

- ☐ Uncountable
- ☒ Countable but infinite
- ☐ Finite
- ☐ Void



Write correct option from (a, b, c, d) *

The language generated by the grammar $S \rightarrow 0S1 \mid 0A1, A \rightarrow 1A \mid 1$ is

- (a) $\{0^m 1^n : m > n > 1\}$
- (b) $\{0^m 1^n : m > n > 1\}$
- (c) $\{0^m 1^n : n > m \geq 1\}$
- (d) $\{0^m 1^n : n > m > 1\}$

c

Write correct option from (a, b, c, d) *

Which of the following identity doesn't hold?

- (a) $\varepsilon R = R\varepsilon = R$
- (b) $\varepsilon + R = R + \varepsilon = R$
- (c) $\phi R = R\phi = \phi$
- (d) $\phi + R = R + \phi = R$

b

*

Consider the following two statements:

S1: $\{0^{2n} \mid n \geq 1\}$ is a regular language

S2: $\{0^m 0^n 0^{(m+n)} \mid m \geq 1 \text{ and } n \geq 2\}$ is a regular language. Which of the following is true?

- ☐ a) Only S1 is Correct
- ☐ b) Only S2 is Correct
- ☒ c) Both S1 and S2 are Correct
- ☐ d) None of S1 and S2 is Correct

Write correct option from (a, b, c, d) *

Any string of terminal that can be generated by the following CFG

$S \rightarrow XY, X \rightarrow aX \mid bX \mid a, Y \rightarrow Ya \mid Yb \mid a$

(a) has at least one b

(b) should end in a

(c) has no consecutive a or b

(d) has at least two a

d

*

Which of the following regular expressions describes the language over $\{0, 1\}$ consisting of strings that contain exactly three 0's?

☐ a) $(0 + 1)^* 000(0 + 1)^*$

☒ b) $1^* 01^* 01^* 01^*$

☐ c) $1^* 0001^*$

☐ d) $(0 + 1)^* 0(0 + 1)^* 0(0 + 1)^* 0(0 + 1)^*$

*

A language L is called Turing-decidable (or just decidable), if there exists a Turing Machine M such that on input x , M accepts if $x \in L$ and M rejects otherwise. L is called undecidable if it is not decidable. Which of the following option is false?

☐ a) The class of decidable languages is closed under union

☐ b) The class of decidable languages is closed under complement.

☐ c) The class of decidable languages is closed under intersection

☒ d) None of these



Find the incorrect statement *

- ☐ set of real numbers is not enumerable
- ☐ if a set S is infinite countable then its power set is not countable
- ☒ if L is not recursively enumerable then its complement cannot be recursive
- ☐ family of recursive is a equivalent to family of recursively enumerable

The number of symbols necessary to simulate any TM with m symbols and n states is *

- ☐ $m + n$
- ☒ mn
- ☐ $mn + m$
- ☐ $mn + n$

If we have a procedure to determine whether a given element belongs to a set X or not, then this set is called *

- ☐ Recursive
- ☒ Recursively Enumerable
- ☐ Complete
- ☐ Context-sensitive



*

Which of the following transition IDs given below denotes stack is popped?

- ☒ a) $\delta(q, a, Y) = \{(p, \epsilon)\}$
- ☐ b) $\delta(q, a, Y) = \{(p, Y)\}$
- ☐ c) $\delta(q, a, Y) = \{(q, Y)\}$
- ☐ d) None of the mentioned

*

The number of states in the minimal deterministic finite automaton corresponding to the regular expression $(0 + 1)^*(10)$ is _____

- ☐ a) 2
- ☒ b) 3
- ☐ c) 4
- ☐ d) 5

TM is more powerful than Finite state machine because *

- ☐ tape movement is confined to one direction
- ☐ it has no finite state control
- ☒ it has the capability to remember arbitrary long input symbols
- ☐ none of there



If there exists a language L , for which there exists a TM, T that accepts every word in L and either rejects or loops for every word that is not in L , is said to be *

- ☐ Recursive
- ☐ Recursive enumerable
- ☒ NP-hard
- ☐ None of these

The problem of determining that a Turing Machine would halt after giving Yes / No output is *

- ☐ Unsolvable
- ☐ Solvable
- ☐ Decidable
- ☒ None of these



*

What is the equivalent grammar to that given below containing no unit productions?

$A \rightarrow BC \mid B$

$B \rightarrow C \mid bd$

$C \rightarrow cC \mid d$

$A \rightarrow BC \mid bd \mid cC \mid d$

$B \rightarrow bd$

$C \rightarrow cC \mid d$

☐ a)

$A \rightarrow BC \mid bd$

$B \rightarrow bd$

$C \rightarrow cC \mid d$

☐ b)

$A \rightarrow BC \mid bd \mid cC \mid d$

$B \rightarrow bd \mid cC \mid d$

$C \rightarrow cC \mid d$

☐ d) None of these

☒ c)

*

A formal language is recursive if :

- ☐ a) A total turing machine exists
- ☐ b) A turing machine that halts for every input
- ☐ c) Turing machine rejects if the input does not belong to the language
- ☒ d) All of the mentioned

*

Given an arbitrary non-deterministic finite automaton (NFA) with N states, the maximum number of states in an equivalent minimized DFA is at least.

$$N^2$$

$$2^N$$

- ☐ a)
- ☒ b)
- ☐ c) 2N
- ☐ d) N!



Write correct option from (a, b, c, d) *

Which of the following is true

- (a) $S \rightarrow aSbS \mid bSaS \mid \lambda$ is unambiguous
- (b) $S \rightarrow aB \mid ab, A \rightarrow aAB \mid a, B \rightarrow ABb \mid b$ is unambiguous
- (c) $S \rightarrow AB \mid aaB, A \rightarrow a \mid Aa, B \rightarrow b$ is unambiguous
- (d) $S \rightarrow aB, B \rightarrow Bb \mid b$ is unambiguous

d

Select the false statement *

- ☐ The Turing Machine halting problem is undecidable
- ☒ The Turing Machine halting problem is decidable
- ☐ The blank-tape halting problem is undecidable
- ☐ None of these

Write correct option from (a, b, c, d) *

Which of the following grammars can generate $w = aabbb$

- (a) $S \rightarrow AB, A \rightarrow aA \mid a, B \rightarrow bB \mid b$
- (b) $S \rightarrow AB, A \rightarrow BB \mid a, B \rightarrow AB \mid b$
- (c) both set of production rules
- (d) none

c



*

The number of terms in expression of $(x + y + z)^n$ is

$$\frac{1}{2}(n)(n+2)$$

☐ a)

$$\frac{1}{2}(n+1)(n+2)$$

☒ b)

$$\frac{1}{2}(n+1)(n+3)$$

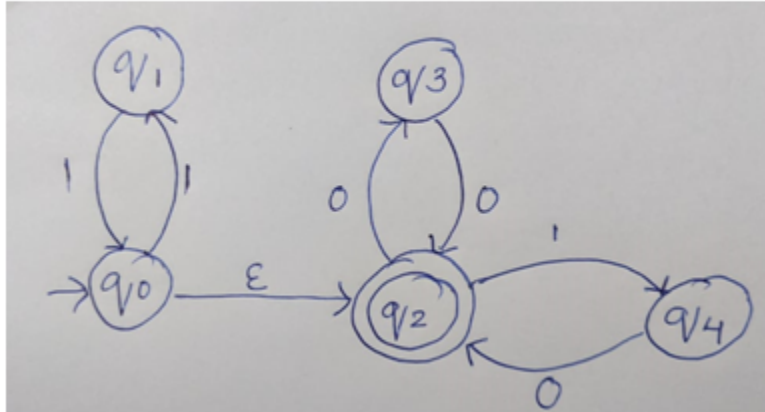
☐ c)

☐ d) None of the above



*

What is the difference in number of state when the given epsilon NFA is Converted to NFA?



- ☐ a) 0
- ☐ b) 1
- ☐ c) 2
- ☒ d) 3

*

Which of the following is an extension to the basic model of Turing machine

- ☒ a) Multitude Turing machine
- ☐ b) Multi-head Turing machine
- ☐ c) Offline Turing machine
- ☐ d) All of the above



If we have an algorithm to determine whether a given element belongs to a set X or not, then this set is called *

- ☒ Recursive
- ☐ Recursively Enumerable
- ☐ Complete
- ☐ Context-sensitive

Write correct option from (a, b, c, d) *

Which of the following is not regular

- (a) string of zero whose length is perfect square
- (b) set of palindromes over 0 and 1
- (c) string of zero whose length is prime
- (d) all of these

d

Write correct option from (a, b, c, d) *

What language is generated by the following grammar $G = \langle S, \Lambda, \{A, B\}, \{a, b\}, P, S \rangle$ where P is

$S \rightarrow aB \mid bA, A \rightarrow a \mid aS \mid bAA, B \rightarrow b \mid bS \mid aBB$

- (a) all words consisting of equal numbers of a's and b's
- (b) all words consisting of one a more than the number of b's
- (c) all words consisting of one b more than the number of a's
- (d) none of these

b



Write correct option (a, b, c, d) *

Which of the following languages is context free?

(a) $L = \{a^m b^m c^n : m \leq n \leq 2^m\}$

(b) $L = \{a^m b^n : n = m^2\}$

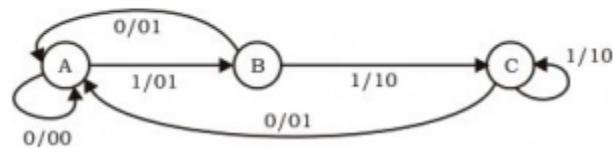
(c) $L = \{a^n \wedge 2 : 1 \leq n\}$

(d) None of these

a

*

The Finite state machine described by the following state diagram with A as starting state, where an arc label is x / y and x stands for 1-bit input and y stands for 2-bit output



- ☒ a) Outputs the sum of the present and the previous bits of the input.
- ☐ b) Outputs 01 whenever the input sequence contains 11.
- ☐ c) Outputs 00 whenever the input sequence contains 10.
- ☐ d) None of these

Which of the following statement is correct? *

- ☐ If the emptiness problem is decidable for Type 3 grammars, then it is also decidable for Type 0 grammars
- ☐ If the emptiness problem is decidable for Type 0 grammars, then it is also decidable for Type 3 grammars
- ☒ If the emptiness problem is undecidable for Type 0 grammars, then it is also undecidable for Type 3 grammars
- ☐ None of these

Finite state machine can be considered to be a TM *

- ☐ a finite tape length, with rewinding and unidirectional movement
- ☒ a finite tape length, without rewinding capability and unidirectional tape movement
- ☐ a finite tape length, without rewinding and bi-directional movement
- ☐ a finite tape length, rewinding capability and bi-directional tape movement

*

How many strings of length less than 3 contains the language described by the regular expression $(a+b)^*b(x+xy)^*$?

- ☐ a) 7
- ☐ b) 4
- ☒ c) 12
- ☐ d) 5



Write correct option from (a, b, c, d) *

The language generated by the grammar $S \rightarrow 0S1 \mid 0A1, A \rightarrow 1A0 \mid 10$ is

(a) $\{0^n 1^m 0^m 1^n : m, n > 1\}$

(b) $\{0^n 1^m 0^m 1^n : m, n \geq 1\}$

(c) $\{0^m 1^n : n, m \geq 1\}$

(d) $\{1^m 0^n : n, m \geq 1\}$

b

*

Let Σ be a finite non-empty alphabet and let $2\Sigma^*$ be the power set of Σ^* . Which one of the following is TRUE?

- ☐ a) Both $2\Sigma^*$ and Σ^* are countable
- ☐ b) $2\Sigma^*$ is countable and Σ^* is uncountable
- ☒ c) $2\Sigma^*$ is uncountable and Σ^* is countable
- ☐ d) Both $2\Sigma^*$ and Σ^* are uncountable

*

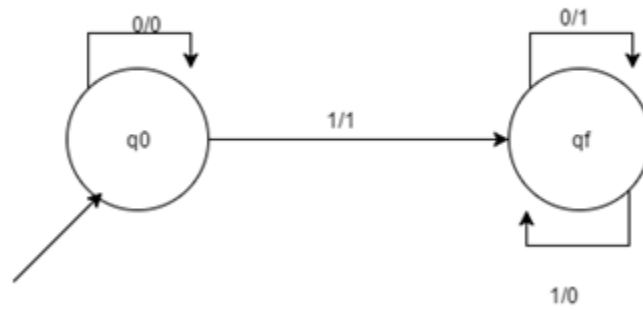
Language of finite state machine is

- ☐ a) Type 0
- ☐ b) Type 1
- ☐ c) Type 2
- ☒ d) Type 3



*

The following mealy machine outputs which of the following?



- ☐ a) 9's Complement
- ☒ b) 2's Complement
- ☐ c) 1's Complement
- ☐ d) 10's Complement

*

Can we use PDA to recognize the following language: $L = \{a^i c^j \mid i = j \text{ and } i, j \geq 1\}$?

- ☒ a) True
- ☐ b) False

*

Which of the following is true for the language $\{a^p | p \text{ is a prime}\}$

- ☐ a) It is not accepted by a Turing 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

*

Let $P(n)$ be the statement that $1^2 + 2^2 + \dots + n^2 = n(n+1)(2n+1)/6$ for $n > 0$.
What is the statement $P(1)$?

$$1^2 + 2^2 + \dots + n^2 = n(n+1)(2n+1)/6$$

☐ b) $n=1$

☐ a)

☐ c) It doesn't exist

$$1^2 = 1(1+1)(2+1)/6$$

☒ d)

Write correct option from (a, b, c, d) *

The regular expression $(1+00^*1)+(1+00^*1)(0+0+10^*1)^*(0+10^*1)$ is equivalent to

- (a) $0^*1(0+10^*1)^*$
- (b) $(1+00^*1)(0+10^*1)^*$
- (c) $(1+00^*1)(0^*(10^*1)^*)^*$
- (d) all of these

d

*

The length of the shortest string NOT in the language (over $\Sigma = \{a, b\}$) of the following regular expression is _____.

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

- ☐ a) 2
- ☒ b) 3
- ☐ c) 4
- ☐ d) 5

*

Consider the following CFG, G:

$S \rightarrow AaS \mid \epsilon$

$A \rightarrow SbB$

$B \rightarrow bCC$

$C \rightarrow cD \mid Ec$

$D \rightarrow abAA$

$E \rightarrow bc$

$F \rightarrow bBC$

The number of useless symbols in the grammar is,

☐ a) 0

☐ b) 1

☒ c) 2

☐ d) 5

Write correct option from (a, b, c, d) *

The grammar that generates $L = \{wcw^t \mid w \in \{a, b\}^*\}$ is

(a) $S \rightarrow aSa \mid bSb \mid aca \mid bcb$

(b) $S \rightarrow aSa \mid bSb \mid c$

(c) both set of production rules

(d) none of these

c



Which of the following is accepted by an NPDA and not DPDA? *

- ☐ all strings in which a given symbol is present atleast twice
- ☒ even palindromes (i.e. palindromes made up if even no of symbols)
- ☐ string ending with a particular alphabet
- ☐ none of these

Write correct option from (a, b, c, d) *

Let G be the grammar $S \rightarrow aA$, $A \rightarrow Abb \mid b$, sentential forms of G are

- (a) aAb^{2n} , ab^{2n+1} where, $n \geq 0$
- (b) aAb^{2n} , ab^{2n+1} where, $n \geq 1$
- (c) aAb^{2n} , ab^{2n} where, $n \geq 0$
- (d) none of these

a

Write correct option from (a, b, c, d) *

Which of the following grammars is ambiguous?

- (a) $S \rightarrow a \mid abSb \mid aAb$, $A \rightarrow bS \mid aAAb$
- (b) $S \rightarrow aB \mid ab$, $A \rightarrow aAB \mid a$, $B \rightarrow ABb \mid b$
- (c) $S \rightarrow S + S \mid S * S \mid a \mid b$
- (d) all of these

d



Write correct option from (a, b, c, d) *

The grammar that generates $L = \{a^n b^n c^i \mid n=1, i=0\}$ is

- (a) $S \rightarrow A \mid Sc, A \rightarrow ab \mid aAb$
- (b) $S \rightarrow aAb \mid Sc, A \rightarrow ab \mid aAb$
- (c) both set of production rules
- (d) none of these

c

Write correct option from (a, b, c, d) *

Which of the following languages cannot be produced by a regular grammar?

- (i) $\{a^n b^n : n > 0\}$ (ii) $\{a^m b^k : k > n \geq 0\}$ (iii) $\{ww^R : w \in \{a, b\}^*\}$
- (a) (i)
 - (b) (i) and (ii)
 - (c) (ii) and (iii)
 - (d) all of these

d

Find the false statement *

- ☒ L is recursively enumerable then so is complement of L
- ☐ L is recursive then so is complement of L
- ☐ L is recursive then complement of L is recursively enumerable
- ☐ If L and complement of L are recursively enumerable then both are recursive

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