Q.1) Max Marks: 1

Consider the following context free grammar
S → aXa | bXb | a | b
X → aX | bX | ε
The language generated by the given CFG is

A Set of all odd length palindromes over the alphabet {a,b}

B Set of all even length palindromes over the alphabet {a,b}

C All nonempty strings that start and end with the same symbol over the alphabet {a,b} Correct Option

Solution: (C)

Answer: C
Explanation:
S → aXa | bXb | a | b
X → aX | bX | ε
The strings that are generated by the given grammar is
={a,b, aa,bb, aaa,bbb,aba,bab,aaba,babb,.....}
Every string starting and ending with the same symbol.

D None of the above

Q.2) Max Marks: 1

Consider the following context free grammar
S → aAA
A → aS|bS|a
Then the number of transition functions in the PDA equivalent to the given CFG is____

Correct Answer

Solution: (6)

Answer: 6
Explanation:
The PDA P = (Q, Σ, Γ, δ, q0, Z0, F) is defined as
Q = {q}
Σ = {a, b}
Γ = {a, b, S, A}
q0 = q
Z0 = S
F = {}
And the transition function is defined as:
δ(q, ε , S) = {(q, aAA)}
δ(q, ε , A) = {(q, aS),(q, bS),(q, a)}
δ(q, a, a) = {(q, ε)}
δ(q, b, b) = {(q, ε)}

Q.3) Max Marks: 1

Consider L = {$a^n b^n c^n$: 0 ≤ n ≤ 10000}. Which of the following is True

A L is not regular but CFL

B L is Regular and CFL Correct Option

Solution: (B)

Answer: B
Explanation:
Given Language L = {$a^n b^n c^n$: 0 ≤ n ≤ 10000} is Finite.

All finite languages are Regular.
All regular languages are CFLs.
Hence L is regular and also CFL

C L is neither Regular nor CFL

D L is Regular but not CFL

Q.4) Max Marks: 1

Consider the following context free grammar
$S \rightarrow aSaa \mid B$
$B \rightarrow bB \mid \varepsilon$
The language generated by the given CFG is

A L: $\{a^n a^{2n} \mid n \geq 0\} \cup \{b^m \mid n \geq 0\}$

B L : $\{a^n b^m a^{2n} \mid n,m > 0\}$

C L : $\{a^n b^m a^{2n} \mid n,m \geq 0\}$ Correct Option

Solution: (C)

Answer:C

Explanation:

$S \rightarrow aSaa \mid B$

$B \rightarrow bB \mid \varepsilon$

The possible strings that are generated by the given grammar is

$S \rightarrow B$

$\rightarrow \{\varepsilon, b, bb, bbb, ...\}$

$S \rightarrow aBaa$

$\rightarrow \{aaa, abaa, abaa, aaaaaa, ...\}$

$= \{\varepsilon, b, bb, bbb, aaa, abaa, abbaa, aaaaaa, ...\}$

We can have any number of b's and for every a there exactly 2 a's exist in the string.

$L = \{a^n b^m a^{2n} \mid n,m \geq 0\}$

D L : $\{a^n b^n a^{2n} \mid n \geq 0\}$

Q.5) Max Marks: 1

Which of the following statements are False

A If a language is context free it can be always accepted by a deterministic push down automata Correct Option

Solution: (A)

Answer: A

Explanation:

If a language is context free it can be always accepted by a deterministic push down automata False

Let $L=ww^R$ which is CFL accepted by the non deterministic push down automata but not accepted by the deterministic PDA.

If a language is regular it can be always accepted by a non deterministic finite automata

True

Every regular language

B If a language is regular it can be always accepted by a non deterministic finite automata

C Context free languages are not closed under set difference operation

D Context sensitive languages are closed under kleene star operation

Q.6) Max Marks: 1

Which of the following languages are undecidable

I. $L_1 = \{<M> \mid M$ is a Turing Machine that accepts w^R whenever it accepts $w\}$

II. $L_2 = \{<M> \mid M$ is a regular expression which generates at least one string containing an odd number of 1's$\}$

III. L_3 = {<G> | G is a context free grammar which generates at least one string of all 1's}

IV. L_4 = {<M> | M is a Turing machine that has a state which is never entered on any input}

A I and II only

B II and III only

C III and IV only

D I and IV only — Correct Option

Solution: (D)

Answer: D

Explanation:

L_1 = {<M> | M is a Turing Machine that accepts w^R whenever it accepts w} Undecidable

L_2 = {<M> | M is a regular expression which generates at least one string containing an odd number of 1's} Decidable

L_3 = {<G> | G is a context free grammar which generates at least one string of all 1's} Decidable

L_4 = {<M> | M is a Turing machine that has a state which is never entered on any input}

Undecidable

All non-trivial properties of Turing machines are decidable

Q.7) Max Marks: 1

Which of the following is/are decidable

I. A_{CFG} = {< G, w >| G is a CFG and w ∈ L(G)}

II. E_{CFG} = {< G >| G is a CFG and L(G) = ∅}

III. EQ_{CFG} = {< G, H >| G, H are CFGs and L(G) = L(H)}

IV. EQ_{DFA} = {< G, H >| G, H are DFAs and L(G) = L(H)}

A I,II, and III Only

B II,III and IV only

C I,II and IV Only — Correct Option

Solution: (C)
Answer: C
Explanation:
I. Membership of CFG is decidable
II. Emptiness of CFG is decidable
III. Equivalence of CFG is undecidable
IV. Equivalence of DFA is decidable

D All are decidable

Q.8) Max Marks: 1

Which of the following is/are FALSE

A CFLs are closed under Reversal Operation

B CFLs are not closed under Complement and set difference

C CFLs are closed under intersection with regular languages

D CFLs are closed under intersection and homomorphism operations — Correct Option

Solution: (D)
Answer:D
CFLs are closed under Reversal Operation : True
CFLs are not closed under Complement and set difference: True
CFLs are closed under intersection with regular languages : True
CFLs are closed under intersection and homomorphism operations: False
CFLs are closed under homomorphism but not under intersection operation.

Q.9) Max Marks: 1

Which of the following is/are True

A **DCFLs are closed under complement operation** — Correct Option

Solution: (A)
Answer:A
Explanation:
DCFLs are closed under complement operation: True
Recursive languages are closed under homomorphism: False
Recursive enumerable languages are closed under Complementation: False
DCFLs are closed under union operation: False

B **Recursive languages are closed under homomorphism**

C **Recursive enumerable languages are closed under Complementation**

D **DCFLs are closed under union operation**

Q.10) Max Marks: 1

. Which of the following languages are not Context free

I. $L = \{a^n b^j \mid n \leq j^2\}$
II. $L = \{a^n b^j \mid n \leq (j-1)^3\}$
III. $L = \{a^n b^j c^k \mid k = jn\}$

A **All are context free**

B **I and II only**

C **II and III only**

D **None of these** — Correct Option

Solution: (D)

Answer: D

Explanation:

$L = \{a^n b^j \mid n \leq j^2\}$ Non CFL

$L = \{a^n b^j \mid n \leq (j-1)^3\}$ Non CFL

$L = \{a^n b^j c^k \mid k = jn\}$ Non CFL

One stack PDA is not sufficient to accept the given languages. So all are not context free.

Q.11) Max Marks: 2

Let M be a Turing machine defined by

δ	B	a	b	c
q_0	q_1,B,R			
q_1	q_2,B,L	q_1,a,R	q_1,c,R	q_1,c,R
q_2		q_2,c,L		q_2,b,L

Then the output produced by the Turing machine M for the input string bcbc is

A **bcbc**

B **cccc**

C **acac**

D **bbbb** — Correct Option

Solution: (D)

Answer:D

Explanation:

Initially tape contains

B	b	c	b	c	B

$q_0 Bbcbc B$
$\vdash B q_1 bcbc B$
$\vdash B c a_1 cbc B$

$\vdash Bccq_1bcB$
$\vdash Bcccq_1cB$
$\vdash Bccccq_1B$
$\vdash Bcccq_2cB$
$\vdash Bccq_2cbB$
$\vdash Bcq_2cbbB$
$\vdash Bq_2cbbbB$
$\vdash q_2BbbbbB$

Q.12) Max Marks: 2

Which of the following languages are context free

I. L= {$a^n ww^r a^n$ | $n \geq 0$, $w \in (a+b)^*$}
II. L= {$a^n b^j a^n b^j$ | $n \geq 0$, $j \geq 0$ }
III. L= {$a^n b^j a^j b^n$ | $n \geq 0$, $j \geq 0$ }

A All are context free

B I and II only

C II and III only

D I and III only — Correct Option

Solution: (D)

Answer: D

I. L= {$a^n ww^r a^n$ | $n \geq 0$, $w \in (a+b)^*$} CFL
We construct a PDA for the language by applying the following operations.
We will apply push operation for all a's and w part of the string.
Start applying the pop operation for all the symbols of w^r and then followed by all a's.
After reaching the end of the string pda will reaches the final state and the stack is empty.

II. L= {$a^n b^j a^n b^j$ | $n \geq 0$, $j \geq 0$ } Not CFL
Seems to be CFL, but with one stack PDA we cannot check the equality between a^n and a^n, b^j and b^j.
We need a minimum two stacks for checking the equality between a^n and a^n, b^j and b^j.

III. L= {$a^n b^j a^j b^n$ | $n \geq 0$, $j \geq 0$ } CFL
Push all symbols of $a^n b^j$ and start applying pop operation for all the symbols of $a^j b^n$. Here first we need to check the equality between $b^j a^j$ and then $a^n b^n$.

Q.13) Max Marks: 2

Which of the following languages are not Context free

a. {$0^n 1^n 0^n 1^n$| $n \geq 0$}
b. {$0^n \#0^{2n} \#0^{3n}$| $n \geq 0$}
c. {w#t|w is a substring of t,where w,t$\in${a,b}*}
d. {$t_1 \#t_2 \#...\#t_k$|k≥2, each $t_i \in$ {a,b}*, and $t_i = t_j$ for some $i \neq j$}

A I and II Only

B I ,II and IV only

C III and IV only

D I,II,III and IV Only — Correct Option

Solution: (D)

Answer: D

Explanation:

I. {$0^n 1^n 0^n 1^n$| $n \geq 0$} Not CFL, Requires more than one stack to check the equality between $0^n 1^n$, $1^n 0^n$, $0^n 1^n$ etc.
II. {$0^n \#0^{2n} \#0^{3n}$| $n \geq 0$} Not CFL. Requires more than one stack to check the equality between 0^n and 0^{2n}, 0^{2n} and 0^{3n}, 0^n and 0^{3n} etc.
III. {w#t|w is a substring of t,where w,t$\in${a,b}*}

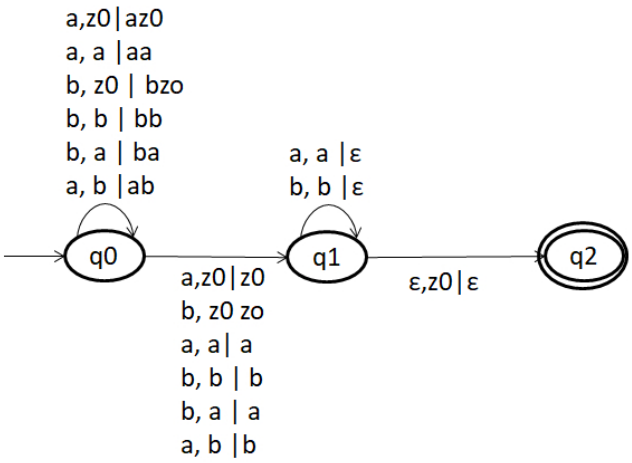
Assume that L is context-free. Let p be the pumping length of L and s = $10^p\#10^p$. By the pumping lemma for context-free languages, we have s = uvxyz satisfying the following. • $uv^ixy^iz \in L$ for i = 0, 1, 2, . . ., and • |vy| > 0, and • |vxy| ≤ p.
We do a case analysis here.
• Either v or y contains #. Then uvvxyyz contains more than one #'s, which contradicts uvvxyyz ∈ L.
• vxy occurs before #. Then uvvxyyz = w1#w2 for some w1, w2 such that w1 is longer than w2. Therefore, w1 cannot be a substring of w2, contradicting uvvxyyz ∈ L.
• vxy occurs after #. Then uxz = w1#w2 for some w1, w2 such that w1 is longer than w2. Therefore, w1 cannot be a substring of w2, contradicting uxz ∈ L.

• x straddles #. We have two subcases.
– y begins with 1.
Then uxz = w1#w2 for some w1, w2 such that w1 begins with 1 and w2 consists of 0's. Therefore, w1 cannot be a substring of w2, contradicting uxz ∈ L.
– y = ε. Then uvvxyyz = w1#w2 for some w1, w2 such that w1 is longer than w2. Therefore, w1 cannot be a substring of w2, contradicting uvvxyyz ∈ L. Therefore, L is not context-free.

IV. $\{t_1\#t_2\#...\#t_k | k\geq 2$, each $t_i \in \{a,b\}^*$, and $t_i = t_j$ for some $i \neq j\}$ Requires more than one stack to check the pairs t_1 and t_2 , t_2 and t_3 and..... Non CFL

Q.14) Max Marks: 2

Consider the following pushdown automata



The Language accepted by the given PDA is

A **Set of all the palindromes over the alphabet {a,b}**

B **Set of all even length palindromes over the alphabet {a,b}**

C **Set of all odd length palindromes over the alphabet {a,b}** Correct Option

Solution: (C)

Answer:C

Explanation:

Given PDA is a non deterministic pda defining multiple transitions for q0(a,a), q0(b,b) etc
Let's consider an example string ababa and assume w=ab, w^r =ba
"ab" will be pushed onto the stack and "a" will be skipped and for the string "ba" pda will apply pop operation.
The PDA will accept all the odd length palindromes starting from a,b

Option A:

Set of all the palindromes over the alphabet {a,b}
Let's consider an example aaaa
assume w=aa and w^r =aa
Then pda apply push operation on w, aa will be pushed onto the stack and for first in w^r will be skipped and the state is moved from q0 to q1,
Q1 on a,a will apply pop operation still one 'a' left on the stack. Q1 on (ε ,a) is not defined. PDA will not reach the final state. So the PDA is not accepting all the palindromes.

Option B:
PDA is not accepting the even length palindromes like aa,bb, abba,**aaaa**,.....

D None of these

Q.15) Max Marks: 2

The Context free grammar that generates the given language is
$L=\{ a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i + j = k \}$

A $S \rightarrow aSc \mid bSc \mid \varepsilon$

B $S \rightarrow aSc \mid X$
$X \rightarrow bXc \mid \varepsilon$ Correct Option

Solution: (B)

Answer: B
Explanation:
Given language $L=\{ a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i + j = k \}$
The strings in the language = {ε, ac, bc, aacc, bbcc, abcc, aabccc, abbccc , aabbcccc, ...}
$S \rightarrow aSc \mid X$
$X \rightarrow bXc \mid \varepsilon$
Option A:
$S \rightarrow aSc \mid bSc \mid \varepsilon$ will generate the strings like bacc, baaccc,...
Which are not part of the language.

Option C:
$S \rightarrow aSb \mid X$
$X \rightarrow bXc \mid \varepsilon$
Will generate the string ab which is not a part of the given language.

C $S \rightarrow aSb \mid X$
$X \rightarrow bXc \mid \varepsilon$

D None of these

close