

**KIIT Deemed to be University**

**Online End Semester Examination(Spring Semester-2022)**

**Subject Name & Code:** **AFL (CS-2010)** **Applicable to Courses:**

**Full Marks: 50** **Time: 2 Hours**

**SECTION-A(Answer All Questions. Each question carries 2 Marks)**

**Time:30 Minutes (7×2=14 Marks)**

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| **Question No** | **Question Type (MCQ/SAT)** | **Question** | **CO Mapping** | **Answer Key**  **(For MCQ Questions only)** |
| **Q.No:1** | **MCQ** | Which of the following strings is accepted by the following FA.     1. 111000 2. 000111 3. 010101 4. All from the list. | Concept 1 | **D.** All from the list. |
|  |  | Which of the strings is not accepted by the following FA.     1. 111000 2. 000111 3. 010001 4. 010011 | Concept 1 | **C. 010001** |
|  |  | A regular expression for the below FA is:     1. 10+(0+1)0\*1. 2. 11+(0+11)0\*1. 3. 10+(0+11)0\*1. 4. None | Concept 1 | **C.** 10+(0+11)0\*1. |
|  |  | Which of the following language is regular? (A) {an bn | n>=0}  (B){ak bk | 0<k<5} (C) {am bm | m>=1} (D)None | Concept 1 | **B.** {ak bk | 0<k<5} |
| **Q.No:2** | **MCQ** | Consider the following two statements:  S1. The minimal number of states required to construct a DFA to accept set of all strings of length greater than equal to 5 is ≥ 5.  S2. The minimal number of states required to construct a DFA to accept set of all strings of length exactly 6 is 7.  Which one of the following is correct?   1. Both S1 and S2 True. 2. S1 True and S2 false 3. S1 False and S2 True 4. Both S1 and S2 false | Concept 2 | **D.** Both S1 and S2 false |
|  |  | The language generated by the grammar  **S-> aSa | bSb | a | b** ,  over the alphabet {a, b} is the set of:   1. All even length palindromes 2. All odd length palindromes 3. All odd and even length palindromes 4. Strings that begin and end with the same symbol | Concept 2 | **B.** All odd length palindromes |
|  |  | Select the correct statement for the regular expression: **(a+ λ)(b+ba)\***   1. Generating a set of strings which ends with a. 2. Generating a set of strings which ends with b. 3. Generating strings which do not contain any consecutive a’s. 4. Generating strings which do not contain any consecutive b’s. | Concept 2 | **C.**  Generating strings which do not contain any consecutive a’s. |
|  |  | Select the correct statement for the regular expression: (**b+ab)\*** **(a+ λ)**   1. Generating a set of strings which ends with a. 2. Generating a set of strings which ends with b. 3. Generating strings which do not contain any consecutive a’s. 4. Generating strings which do not contain any consecutive b’s. | Concept 2 | **C.**  Generating strings which do not contain any consecutive a’s. |
| **Q.No:3** |  | The language generated by the grammar  **S-> aSa | bSb| λ**  over the alphabet {a, b} is the set of:   1. All even length palindromes 2. All odd length palindromes 3. All odd and even length palindromes 4. Strings that begin and end with the same symbol | Concept 3 | **A.** All even length palindromes |
|  |  | The language {an bn cm dm| n, m ≥ 0} ∪{ an bm cm dn| n, m ≥ 0} is   1. Unambiguous 2. Cannot be determined 3. Inherently ambiguous 4. Not a CFL | Concept 3 | 1. Inherently ambiguous |
|  |  | Consider the given grammar.  S-> aA | bB  A-> aA|a  B->bB  D->ab|Ea  E->aC|d  The equivalent grammar after eliminating the useless symbols and productions:   1. S->aA, A->aA|a 2. S->aS|bA|C, A->a, C->aCd 3. S->aA|bB, A->aA|a, B->bB 4. Cannot remove useless symbol | Concept 3 | 1. S->aA, A->aA|a |
|  |  | The language generated by the grammar  S-> aSb | aAb  A->cA|c is:   1. an bn cn (n, m ≥1) 2. an cm bn (n, m ≥1) 3. an bn cm, (n, m ≥1) 4. am cm bn (n, m ≥1) | Concept 3 | **B.** an cm bn (n, m ≥1) |
| **Q.No:4** |  | Which one of the following is not a CFL ?   1. {am bm cm : m≥0} 2. {an bn : n≥0} 3. {am+n bm cn : m≥0 and n≥0} 4. {am bm cn dn : m≥0 and n≥0} | Concept 4 | ***A. {am bm cm m≥0}*** |
|  |  | Let L1={am bm :m≥0} and L2=={ambm : 0<m<50}. Then L1∩ is:   1. Regular 2. Context free 3. Regular but not context free 4. Not context-free | Concept 4 | **B. Context free** |
|  |  | Consider the language L1={an bn:n≥0} and L2=={a100 b100}. The relation L1∩   1. Context free 2. Regular 3. Regular but not context free 4. Not context-free | Concept 4 | **A. Context free** |
|  |  | Which of the following is / are not necessarily CFL?   1. L1(CFL)∩ L2(Regular language) 2. L1(CFL) ∪ L2(Regular language) 3. L1(CFL) ∩ L2(CFL) 4. if L2(CFL) 5. All 6. ii, iii 7. iii, iv 8. i, iii, iv | Concept 4 | **C.** iii, iv |
| **Q.No:5** |  | Consider the following statements:    S1. A CFG is unambiguous if it a simple grammar  S2. A CFG is unambiguous if it is in Greibach  Normal form  Which of the following is True?   1. S1 and S2 are true 2. S1 is true and S2 is false 3. S1 is false and S2 is true   true   1. S1 and S2 both are false | Concept 5 | 1. S1 is true and S2 is false |
|  |  | Consider the following statements:    S1. A CFG is unambiguous if it is in CNF.  S2. A CFG is unambiguous if it is in GNF.  Which one of the following is True?   1. S1 and S2 both are true 2. S1 true and S2 false 3. S1 false and S2 true 4. S1 and S2 both are false | Concept 5 | **D.** S1 and S2  **D.** S1 and S2 both are false |
|  |  | Consider the following statements:  S1. If the CFG(G)does not have any λ-productions (lambda-productions), then L(G) does not contain the empty string λ.  S2. If the CFG(G) has λ-productions (lambda-productions), then L(G) must contain the empty string λ.  Which one of the following is true?   1. S1 and S2 both are true 2. S1 and S2 both are false 3. S1 is false and S2 is true 4. S1 is true and S2 is false | Concept 5 | **D.** S1 is true and S2 is false |
|  |  | Consider the following statements  S1. If two CFGs are equivalent, then either both of them are unambiguous or both of them are ambiguous  S2: The grammar **S->aB|AB, A->aB|a, B->b,** is in Chomsky Normal Form:   1. S1 and S2 both are true 2. S1 true and S2 false 3. S1 and S2 both are false 4. S1 false and S2 true | Concept 5 | **C.** S1 and S2 both are false |
| **Q.No:6** |  | Which of the following pairs of family are not equivalent?   1. NFA and DFA 2. NPDA and DPDA 3. Deterministic single tape TM and Nondeterministic single tape TM 4. Single tape TM and Multi tape TM | Concept 6 | **B.** NPDA and DPDA |
|  |  | Which one of the following grammars generate the language **L = { an bm | n ≠ m }**   1. S -> AC | CB, C ->aCb | a | b, A ->aA | λ, B -> Bb | λ 2. S ->aS | Sb | a | b 3. S -> AC | CB, C ->aCb | λ, A ->aA | λ, B -> Bb | λ 4. S -> AC | CB, C ->aCb | λ, A ->aA | a, B -> Bb | b | Concept 6 | **D.** S -> AC | CB, C ->aCb | λ, A ->aA | a, B -> Bb | b |
|  |  | Given context-free grammars that generate the following languages  { w ∈ {0, 1}∗ | w = wR and |w| is even }   1. S → 0S0 | 1S1 | λ 2. S → aSa | bSb | λ 3. S → λ 4. S → 1S0 | 0S1 | λ | Concept 6 | **A.** 0S0 | 1S1 | λ |
|  |  | Given context-free grammars that generate the following language  { w ∈ {0, 1}∗ | the length of w is odd and the middle symbol is 0 }   1. S → 0S0 | 1S1 | λ 2. S → 0S0 | 0S1 | 1S0 | 1S1 | 0 3. S → λ 4. S → 1S0 | 0S1 | λ | Concept 6 | **B.** S → 0S0 | 0S1 | 1S0 | 1S1 | 0 |
| **Q.No:7** |  | Consider the following two statements  S1. Given any NFA, there exists an equivalent NPDA  S2. Given any NPDA, there exists an equivalent Turing Machine  Which one of the following is true?   1. S1 is false and S2 is true 2. Both S1 and S2 are true 3. Both S1 and S2 are false 4. S1 is true and S2 is false | Concept 7 | **(B)**Both S1 and S2 are true |
|  |  | Consider the following two statements  S1. Given any Turing machine, there exists an equivalent NPDA  S2. Given any NPDA, there exists an equivalent DPDA  Which one of the following is true?   1. S1 is false and S2 is true 2. Both S1 and S2 are true 3. Both S1 and S2 are false 4. S1 is true and S2 is false | Concept 7 | 1. Both S1 and S2 are false |
|  |  | Consider language L= L1∩L2, where  L1={ ambmanbn | m, n≥0}  L2={ axbycz | x, y, z≥0}  The language L is:   1. Not context free 2. Regular 3. Context free but not regular 4. Recursively enumerable but not context free. | Concept 7 | **C.** Context free but not regular |
|  |  | Consider languages L= L1∩L2, where  L1={ anbmcn+m | m, n≥0}  L2={ anbncm | n, m ≥0}  L3={ anbnc2n | n ≥0}  Which of the following statement is true?   1. L1, L2 are context free 2. L1, L3 are context free 3. L3= L1∩L2 4. L1, L3 are context free but not L2. | Concept 7 | 1. L1 and L2 are context free |

**SECTION-B(Answer Any Three Questions. Each Question carries 12 Marks)**

**Time: 1 Hour and 30 Minutes** **(3×12=36 Marks)**

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| 8. *(i)* Convert the given NFA to DFA. Find equivalent DFA that has minimum number of states from the obtained DFA.    λ  λ    8. (ii) Construct a left-linear and a Right-linear grammar equivalent to your DFA. Find a regular expression for the DFA. |
| 8. *(i)* Convert the following NFA to DFA. Find equivalent DFA that has minimum number of states.  .    *8.* (ii) Construct a left-linear and a Right-linear grammar equivalent to the DFA. Find a regular expression for the DFA. |
| 8. *(i)* Convert the following NFA to DFA. Null transition is from state q1 to q3. Find equivalent DFA that has minimum number of states.  8. *(ii)* Construct a left-linear and a Right-linear grammar for the DFA. Find a regular expression for the DFA. |
| 9. *(i)* Transform the CFG into Chomsky normal form (CNF) and Greibach Normal form (GNF).  **S → AB|aB,**  **A → abb|λ,**  **B → bbA**  9. *(ii)* Design a DFA that accepts the language generated by the following grammar. Find a left-linear grammar for the DFA.  **S → abA,**  **A → baB,**  **B → aA|bb.** |
| 9. *(i)* Transform the following CFG into Chomsky normal form (CNF) and Greibach Normal form (GNF).  **S → ASA|aB**  **A → B/S**  **B → b/ λ**  9. (ii)  Find a regular grammar that generates the language  **L = {w ∈ {a, b}∗ : na (w) + 3nb (w) is odd} .** |
| 9 *(i)* Transform the following grammar into Chomsky normal form(CNF) and Greibach Normal form(GNF).  **S → baAB,**  **A → bAB|λ,**  **B → BAa |A| λ**  Q9. (ii)  Find a regular grammar for the language **L = {anbm : n + m is odd}.** |
| 10. (i) Design an *NPDA* for the language **L = { ambncp : m, n, p ≥ 1 and m = n + p }.**  10. (ii) Find an *NPDA* that accepts **L = {anb2n : n ≥ 3}** |
| 10. (i) Design an *NPDA* for the language, ***L = { 0m1n2p : m, n, p ≥ 1* and *n = m + p}.***  10. (ii) Design an NPDA for the language, ***L = { an+2bncc : n ≥ 1 }.*** |
| 10. (i) Construct an NPDA corresponding to the grammar  S → aABB|aAA,  A → aBB|b,  B → bBB|A.  10. (ii) Design an NPDA for ***L = { anbmcm+n : m, n ≥ 1 }.*** |
| 11(i) Design a Turing machine for the language, ***L = { cmanbn : m, n ≥ 1 }.***  11(ii) Using pumping lemma for context-free-languages prove that the language  ***L = { w : na(w) = nb(w) = nc(w) + 2 }*** is not context-free. |
| 11(i) Design a Turing machine for the language of all binary strings that  starts with *aa* and ends with *bb.*  11(ii) Using pumping lemma for context-free-languages prove that the language  ***L = { w : 2na(w) = nb(w) = nc(w) }*** is not context-free. |
| 11(i) Design a Turing machine for the language ***L = { anbnc2n: m, n ≥ 1 }.***  11(ii) Using Pumping lemma for regular languages prove that the language  ***L = { w : na(w) =2 nb(w) + 1 }*** is not regular. |