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| Serial No: |
| **Final Exam**  **Section II** |
| **Total Time: 2 Hours** |
| **Total Marks: 80**  **(Part II)** |
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| **CS-301: Theory of Automata** |
| Wednesday, 10th February, 2021 |
| **Course Instructors** |
| Dr Waseem Shahzad, Mehreen Alam. |

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1. This is Part II, the design part of the exam.
2. Attempt all of them. Read the question carefully, understand the question, and then attempt it.
3. No additional sheet will be provided for rough work.
4. After asked to commence the exam, please verify that you have **thirteen (13)** different printed pages including this title page. There are total of **8 questions**.
5. Use permanent ink pens only. Any part done using soft pencil will not be marked and cannot be claimed for rechecking.

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|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | **Total** |
| **Total Marks** | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | **80** |
| **Marks Obtained** |  |  |  |  |  |  |  |  |  |

**Q1. [ 10 pts ]** Design CFG for the language of balanced parenthesis = {Δ, (), ()(), (()), (())()….}

**Q2. [ 10 pts ]** Design PDA for the language EQUAL-EQUAL = { Δ, ab, ba, aabb, bbaa, abab, baba, baab, abba, aaabbb, ….}

**Q3. [ 1+2+2+3+2 = 10 pts ]** Convert to CNF and you must show all the intermediary four steps in the order studied to score full marks:

     S -> SS | AB | B

     A -> aAAa

     B -> bBb | bb | Δ

     C -> CC | a

     D -> aC | bb

**Q4. [ 5+5 = 10 pts ]** Convert to GNF. You must convert to intermediary grammar to get full marks.

     S -> AB

     A -> AB | a

     B -> AB | a

**Q5. [ 10 pts ]** Prove if anbncndn is a non-CFL.

**Q6. [10 pts]** Let L be some regular language in which all the words happen to have an even length. Let us define the new language Twist(L) to be the set of all the words of L twisted, whereby twisted we mean the first and second letters have been interchanged, and so on. For example, if

L = { ba abba babb ……}

Twist(L) = { ab baab abbb ……}

Build a Turing Machine that accepts Twist(L). You are also **allowed** to use the sub programs of **INSERT** and **DELETE**. You may assume after **INSERT** operation, tape head points at the newly added cell while after **DELETE** operation, tape head points at the same location.You may leave the tape head at any location on the output string when the computation is done.

Status of tape on input is: Status of tape at the output is:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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**Q7. [10 pts]** For the language **anb2nc2ndnen**, where n ≥ 0, design a 2-PDA.

**Q8. [10 pts]** Design a Post Machine for the language **EVEN-EVEN**.