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| Serial No: |
| **Final Exam** |
| **Total Time: 2.5 Hours** |
| **Total Marks: 90** |
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| **CS-301Thoery of Automata** |
| Monday, Jan 14, 2019 |
| **Course Instructor(s)** |
| Dr Waseem Shehzad, Dr Labiba Fahad, Noshina Tariq, Mehreen Alam |

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## DO NOT OPEN THE QUESTION BOOK OR START UNTIL INSTRUCTED.

**Instructions:**

1. Attempt on question paper. Attempt all of them. Read the question carefully, understand the question, and then attempt it.
2. If you need more space write on the back side of the paper and clearly mark question and part number etc.
3. After asked to commence the exam, please verify that you have nine **(9)** different printed pages including this title page. There are a total of five **(5)** questions.
4. 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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|  | **Q-1** | **Q-2** | **Q-3** | **Q-4** | **Q-5** | **Total** |
| **Marks Obtained** |  |  |  |  |  |  |
| **Total**  **Marks** | **10** | **20** | **20** | **20** | **20** | **90** |

**Vetted By: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Vetter Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Question 1 [10Marks]**

Prove that the language P = anbnanbn is a non-context free language by using self embedded pumping lemma. You must incorporate the concept of self-embedded-ness.

**Question 2 [20Marks]**

Convert the following grammar to GNF.

S -> Xa | Yb | YYYb

W -> ZZ | SZZ | W | ∆

X -> Sb | b | SZZ

Y -> Sa | a | Z| ∆

Z -> ZZ | SZZ

**Question 3 [20Marks]**

If TM takes a sequence of numbers as input and leaves only one number as output, we call it a computable function. Build a Turing machine that takes as input two positive numbers and performs the multiplication operation on them, i.e **mul(3,7)= 21**. You may use the utilities INSERT and DELETE, if needed. Clearly specify any assumptions and how you are taking the input and leaving the output value.

**Question 4 [20Marks]**

For the language **anbncmdm**, solve using n-stack PDA, where n > 1.

**Question 5 [20Marks]**

Build a Post Machine that takes in any strings of a’s and b’s and leaves in its STORE the complement that has the a’s and b’s switched, e.g. on input abab and bbaa, the output left on the STORE is baba and aabb respectively. You are not allowed to use any sub-programs.