CSC 339 Final

***Important notes**:*

1. *This is an online take-home exam.*
2. *You may **use only** **class notes and the text**.*
3. *You are **not to use** **any other source (e.g Internet)**. Any internet-copied material will be marked as 0*
4. *You are not to discuss the exam with anyone other than the instructor during the examination period (12:30 -3:30 PM).*
5. *Answer **any four** questions from the following, each question on a separate A4 blank page (or any alternative). All questions are equally weighted (5 marks for each question).*
6. *Scan and convert all your answer sheets to a **single pdf** file (you may use any document scanning mobile application).*
7. *Save your file as your student ID.pdf e.g. 43601234.pdf*
8. *From your university email account email your single pdf file to aartoli@ksu.edu.sa*
9. *Your email shall reach me by the end of the exam period (12:30 to 3:30 PM). After that, your submission will not be considered.*

ANSWER ANY FOUR QUESTIONS, each question on a separate sheet:

Question 1

Which of the following statements are True (T) and which of them are False (F)

1. *All regular problems (languages) can be solved with any memory-less computational model.*
2. *The union of the sets of all concatenated context-free languages is also context-free*
3. *A single tape Turing machine which has two heads is equivalent to the single=tape single head Turing Machine.*
4. *There are more computational models than computational problems*
5. *The DFA that accepts the empty language does not exist*
6. *Every Turing machine algorithm needs and input other than the blank symbol*
7. *NP-C problems are not solvable in polynomial time*
8. *If an NP problem A is polynomial time reducible to the acceptance problem ATM, then A can be solved in polynomial space*
9. *For any Context-free language, we can build a Pushdown automaton (PDA) to accept the intersection of a context free language and its complement*
10. *Nondeterministic Turing machines are more powerful than deterministic Turing machines.*

Question 2

a) *Design an NFA automaton N_1 that accepts the language $a^* b^+$*

b) *Design another NFA automaton N_2 that accepts the complement* $\overline{a^* b^+}$

c) *Form the union automaton N of N_1 and N_2 (i.e $N = N_1 \cup N_2$)*

d) *Use the subset construction to convert the N in (c) into its equivalent DFA*

Question 3

We know, the two's complement of a binary number is given by inverting the number and adding 1.

a. *Define a language L which contains all the two's complement digits for a given 3-digit binary number*
b. *Is L in (a) Context -Free?*
c. *Prove or disprove your claim in (b)*

Question 4

a. *Show that EQ_{CFG} is co-Turing recognizable*
b. *A commuter scientist was asked to help deciding whether two blood samples contain similar or different viruses (A=COVID-19 and B= MERS for example) i.e whether or not they are equivalent. By considering that each virus is a set of strings A* and B* where A and B are the genetic structures (contains letters) for each of them.*

    1. *Is this problem decidable?*
    2. *If so (i.e. if it is decidable), use the decidability theory to design a solution. If not, use the reducibility approach to prove that it is NP.*

Question 5

a. *If $A \leq_m B$ and B is a regular language, does this imply that A is a regular language? Why or why not?*
b. *Show that $\overline{PATH}$ is NL*