Name of the Program: B.Sc. in Computer Science and Engineering

Semester: Winter 2020-2021 **Date: 8 September, 2021 Time: 2:30 pm - 4:00 pm**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Semester Final Examination Course Number: CSE 4703

Course Title: Theory of Computing Full Marks: 75

Time: 1.5 Hours

There are 4 (four) questions in this paper. Answer any three questions from them. The symbols and acronyms have their usual meanings. The examination is Online and Closed Book. Programmable calculators are not allowed. Marks of each question and corresponding CO and PO are written in the brackets.

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1. (a) Consider the given language **L = { ww^R | |w| = 2 and $\sum$ = (a, b) }**. The statement about this language "**L is not a regular language**" is true or false? Justify your answer with appropriate explanation. (Here w^R is the reverse string of the string w) 2+5 (CO2) (PO3)

   (b) Arithmetic expressions with operator + and parentheses can be generated by the grammar 5 + 5 (CO4) (PO1, PO2)

   $$E \rightarrow E+E \mid (E) \mid a$$

   where ***a*** stand for any number. This grammar is ambiguous.

   I. Give an example of a string that has two or more leftmost derivations or parse trees.

   II. Design an unambiguous grammar for the same language.

   (c) Write context free grammar that generates/accepts the following language 8 (CO1) (PO1)

   L = { $a^n b^{n+m} c^m$ | n, m $\geq$ 1, $\sum$ = (a, b, c) }

2. (a) Given language L1 and L2 are context free language and described as follows: 12 (CO5) (PO1, PO2)

   L1 = {$a^n b^m c^n$| n,m>=1} and L2 = {$a^n c^n$| n>=1}.

   Construct a push down automata (PDA) that accept the language L1∪L2 (As we know context free languages are closed under union)

(b) Proof that context free language is not closed under complement. (Use intersection closure property of CFL and proof it by contradiction) — 8 (CO1) (PO3)

(c) How do you decide whether a context free language (CFL) is empty? Explain with example. — 5 (CO1) (PO2)

3 (a) Let G be the grammar where V = {S, A, B, C, D} and T = {a, b} — 3+8 (CO1) (PO2, PO3)

S → ABC | BaB

A → aA | BaC | aaa

C → bBb | a | D

D → ε

I. Define the Chomsky Normal Form (CNF) of a grammar.

II. Convert the above grammar G into CNF form.

(b) Design a Turing Machine for the language **L = {$0^n1^n2^n$| n>=1}.** (You need to show the edges that lead to accept state. Ignore the edges that lead to reject state) — 10 (CO4) (PO3)

(c) Transition function is used to define how a machine change/move from one to state to another state. Write the transition function of deterministic Turing Machine and nondeterministic Tuning Machine. — 4 (CO1) (PO2, PO3)

4 (a) What is the purpose of pumping lemma? Show that language **L = {$a^nb^nc^n$| n>=1}** is not context free language using the pumping lemma. — 2 +8 (CO5) (PO2, PO3)

(b) Here is a context-free grammar G: — 12 (CO4) (PO1, PO2)

S → AS | SB | 0

A → BA | AS | 1

B → SB | BA | 0

Apply the CYK algorithm to this grammar and determine whether the string 01100 is the member of the language generated by the above grammar.

(c) Define the decidable language and Turing recognizable language. — 3 (CO5) (PO1, PO2)