NATIONAL INSTITUTE OF TECHNOLOGY TIRUCHIRAPPALLI
CT-II - Jan. 2021 SESSION

DEPARTMENT	: COMPUTER SCIENCE AND ENGINEERING	
DATE & TIME OF EXAM	: 21/04/2021	10:00 am
SUB CODE & Title	: CSPC41- Formal Languages and Automata Theory	
DURATION	: 1 hour + 15mins (for submission)	
FACULTY NAME	: R. LEELA VELUSAMY	Max marks: 20

Note to Student: Answer all the questions. Detailed answer is expected.

1. **Make sure the 'Declaration and statement of authorship' is uploaded along with the answer sheet as cover sheet (First Sheet)**
2. **TIME MANAGEMENT IS YOUR RESPONSIBILITY**

1. Given below is a context free grammar given in Backus-Naur form (BNF) for a simple PASCAL-like programming language: (4)

<stmt> ::= <if-stmt> | <while-stmt> | <begin-stmt> | <assg-stmt>
<if-stmt> ::= **if** <bool-expr> **then** <stmt> else <stmt>
<while-stmt> ::= **while** <bool-expr> **do** <stmt>
<begin-stmt> ::= **begin** <stmt-list> **end**
<stmt-list> ::= <stmt> | <stmt> ; <stmt-list>
<assg-stmt> ::= <var> := <arith-expr>
<bool-expr> ::= <arith-expr> <compare-op> <arith-expr>
<compare-op> ::= < | > | ≤ | ≥ | = | ≠
<arith-expr> ::= <var> | <const> | (<arith-expr> <arith-op> <arith-expr>)
<arith-op> ::= + | - | * | /
<const> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
<var> ::= a | b | C |… | *x* | *y* | *z*

   a. Give a left most derivation for the statement **while** $x \leq y$ **do begin** $x := (x + 1)$; $y := (y - 1)$ **end**
   b. Give a right most derivation for the statement **begin if** $z = (x + 3)$ **then** $y := z$ **else** $y := x$ **end**

2. Find a simplified grammar equivalent to the grammar **G**, having production rules, P: S → AC | B, A → a, B → AB / BC, C → cA | BC | ϵ, E → aA | e. Also, find the language generated by the simplified grammar. (3)
3. Derive a CNF grammar for the set of nonnull strings of balanced parentheses [ ]. (3)
4. Design a pushdown automaton that recognizes the language $\{a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i = j \text{ or } j = k\}$. (4)
5. What language (a subset of {a, b}*) is accepted by the PDA whose transition table is shown below, if the only accepting state is q_3? Prove using valid and invalid strings. (3)

Move Number	State	Input	Stack Symbol	Move(s)
1	q_0	a	Z_0	$(q_0, xZ_0), (q_1, aZ_0)$
2	q_0	b	Z_0	$(q_0, xZ_0), (q_1, bZ_0)$
3	q_0	a	x	$(q_0, xx), (q_1, ax)$
4	q_0	b	x	$(q_0, xx)(q_1, bx)$
5	q_1	a	a	(q_1, a)
6	q_1	b	b	(q_1, b)
7	q_1	a	b	$(q_1, b), (q_2, \Lambda)$
8	q_1	b	a	$(q_1, a), (q_2, \Lambda)$
9	q_2	a	x	(q_2, Λ)
10	q_2	b	x	(q_2, Λ)
11	q_2	Λ	Z_0	(q_3, Z_0)
(all other combinations)				none

6. Show that the following language is context-free. L = {w ε {a, b}* : n_a (w)= n_b (w); w does not contain a substring bab} (3)

Best Wishes