Code No: 156EM **R18**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year II Semester Examinations, March - 2024
AUTOMATA THEORY AND COMPILER DESIGN
(Common to CSBS, CSIT, CE(SE))

Time: 3 Hours **Max. Marks: 75**

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a) What is the formal definition of Nondeterministic Finite Automata? [2]
b) What challenges or limitations are associated with Nondeterministic Finite Automata? [3]
c) Distinguish between leftmost and rightmost derivations. [2]
d) How does ambiguity in grammar affect the understanding and processing of a language? [3]
e) Explain the notion of an instantaneous description in the context of Turing Machines. [2]
f) How does a compiler differ from an interpreter, and what are the advantages of compilation? [3]
g) What are the advantages of LR parsing in syntax analysis? [2]
h) How does the choice of parsing technique impact the efficiency of a compiler? [3]
i) What is a Syntax-Directed Definition, and how does it relate to grammar? [2]
j) How is access to nonlocal data on the stack managed in a run-time environment? [3]

PART – B

(50 Marks)

2.a) Consider non-deterministic finite automata and convert that NFA into equivalent deterministic finite automata.

States/Inputs	a	b
→ q_0	$\{q_0, q_1\}$	q_0
q_1	q_2	q_1
*q_2	q_3	q_3
*q_3	-	q_2

b) Give DFA's accepting the following languages over the alphabet {0, 1}. (i) The set of all strings such that each block of five consecutive symbols contains at least two 0's. (ii) The set of all strings whose tenth symbol from the right end is a 1. [5+5]

OR

3.a) Prove that a language L is accepted by some DFA if and only if L is accepted by some NFA.
b) Give NFA's accepting the following language over the alphabet {0, 1}. The set of all strings that, when interpreted in reverse as a binary integer, is divisible by 5. Examples of strings in the language are 0, 10011, 1001100 and 0101. [5+5]

4.a) Consider the regular expressions, $R_1 = a^* + b^*$ and $R_2 = ab^* + ba^* + b^*a + (a^*b)^*$.
i) Find a string corresponding to R_1 but not R_2.
ii) Find a string corresponding to R_2 but not R_1.
iii) Find a string corresponding to both R_1 and R_2.

b) Prove or disprove each of the following statements about regular expressions.
i) $(R + S)^* = R^* + S^*$
ii) $(R + S)^*S = (R^*S)^*$. [5+5]

OR

5.a) Consider the following grammar.
$S \rightarrow 0A0 \mid 1B1 \mid BB$, $A \rightarrow C$, $B \rightarrow S \mid A$ and $C \rightarrow S \mid \varepsilon$.
(i) Eliminate ε-productions (ii) Eliminate any unit productions in resulting grammar (iii) Eliminate any useless symbols in the resulting grammar.

b) Give an algorithm to tell whether a regular language L contains at least 100 strings. [5+5]

6.a) Design a transition diagram for the turing machine, which accepts the set of all palindromes over {0, 1}. Show the ID's for TM if the input tape contains the following strings. (i) 100101 (ii) 0110110.

b) Prove that the halting problem of the Turing machine is undecidable. [5+5]

OR

7.a) Convert the expression grammar to a PDA.
$I \rightarrow a \mid b \mid Ia \mid Ib \mid I0 \mid I1$, $E \rightarrow I \mid E * E \mid E + E \mid (E)$.

b) Explain about an undecidable problem with an example. [5+5]

8.a) Consider the Grammar.
$E \rightarrow T E'$
$E' \rightarrow + T E' \mid \varepsilon$
$T \rightarrow F T'$
$T' \rightarrow * F T' \mid \varepsilon$
$F \rightarrow id \mid (E)$
NOTE: ε denotes epsilon.
Find the first and follow sets. Find the LL(1) parsing table. Determine whether the grammar is LL(1) or not.

b) Construct an LR parsing table for the given context-free grammar.
$S \rightarrow AA$
$A \rightarrow aA \mid b$ [5+5]

OR

9.a) In the following context-free grammar, the symbols (, a,) and , are terminals and S is the initial symbol.
$S \rightarrow (L)$
$S \rightarrow a$
$L \rightarrow L , S$
$L \rightarrow S$
As, is a symbol of the language, you have to use | as a separator between the core of the LR(1) items and the look ahead symbols. Look aheads with the same core can be separated as usual with /.
i) Calculate the closure of the LR(1) item [$S \rightarrow (. L) \mid \$$]
ii) Construct the full LR(1) DFA, showing all items in each state.
iii) Construct the LR(1) parsing table using the DFA. For the reduce actions, use the provided enumeration of the productions in the grammar.

b) Construct a CLR parsing table for the given context-free grammar.
$S \rightarrow AA$
$A \rightarrow aA|b$ [5+5]

10.a) Construct a syntax-directed translation scheme that translates Roman numerals up to 2000 into integers.
b) Construct the DAG for the expression: ((x + y) - ((x + y) * (x - y))) + ((x + y) * (x - y)) and x + x + (x + x + x + (x + x + x + x)). Assumption: + associates from the left. [5+5]

OR

11.a) Explain peephole optimization with an example.
b) Generate code for the following three-address sequence, assuming that p and q are in memory locations.
y = *q
q = q + 4
*p = y
p = p + 4 [5+5]

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