B5.2-R4: AUTOMATA THEORY AND COMPILER DESIGN

NOTE:

1. **Answer question 1 and any FOUR from questions 2 to 7.**
2. **Parts of the same question should be answered together and in the same sequence.**

Time: 3 Hours **Total Marks: 100**

1.

a) How strings differ from words of a language? Given an alphabet ∑, what do you mean by a language L over ∑?
b) What is the difference between deterministic and nondeterministic finite state automata?
c) Distinguish between context free and context sensitive language.
d) When is a language said to be recursively enumerable?
e) What is a cross compiler? Give an example.
f) What are the disadvantages of operator precedence parsing?
g) What is meant by peephole optimization? What are its characteristics?

(7x4)

2.

a) Show that *R* is an equivalence relation in the following question:
R is the relation on the set of integers such that *(a,b)* Ɛ *R* if and only if $3a + 4b = 7n$ for some integer *n*.
b) Use mathematical induction to prove that $n^3 + 2n$ is divisible by 3, for $n \geq 1$.
c) Solve the recurrence relation $a_n = 2a_{n-1} + 2^n$; $a_0 = 2$.

(6+6+6)

3.

a) Show that the language $L = \{a^k \mid k = i^2, i \geq 1\}$ is not a finite state language.
b) Construct the transition diagram of the finite automaton M given below and then a minimum state automaton equivalent to M.
M = (Q, ∑, δ, q_0, F) where Q = {q_0,q_1,q_2,q_3,q_4,q_5,q_6,q_7}, ∑ = {0,1}, F = {q_2} and δ given as follows.

δ	**0**	**1**
q_0	q_1	q_5
q_1	q_6	q_2
q_2	q_0	q_2
q_3	q_2	q_6
q_4	q_7	q_5
q_5	q_2	q_6
q_6	q_6	q_4
q_7	q_6	q_2

(9+9)

4.

a) Construct a context-free grammar that generates the set of strings of the form $a^m b^n c^p$; $m, n, p \geq 1$ and hence find the PDA that accepts such strings.
b) Obtain a grammar in Chomsky Normal Form (CNF) equivalent to the grammar G with productions P given by $S \rightarrow AACD$, $A \rightarrow aAb \mid \varepsilon$, $C \rightarrow aC \mid a$, $D \rightarrow aDa \mid bDb \mid \varepsilon$.

(9+9)

5.

a) Construct a Turing machine that computes the function $f(n) = n - 3$, if $n \geq 3$ and $f(n) = 0$ for $n = 1, 2$ for all positive integers n.

b) Differentiate between P, NP, NP-complete, and NP-hard problems with appropriate examples.

c) Define passes of a compiler. Which are the factors that decide number of passes for a compiler?

(9+6+3)

6.

a) Consider the grammar:

$A \rightarrow a\ A\ a$
$B \rightarrow b\ A\ b$
$A \rightarrow \varepsilon$

i) Describe the language that the grammar defines.
ii) Is the grammar ambiguous? Justify your answer.
iii) Construct a SLR parse table for the grammar.
iv) Can the conflicts in the table be eliminated?

b) For the assignment instruction below performs the following:

x = (a + (b * 2)) + 1

i) Augment the Syntax Directed Translation (SDT) scheme with a rule corresponding to the production E → const and using a "value" attribute for the constant with its numeric value.
ii) Generate three-address instructions using the SDT scheme and without any minimization of temporaries.
iii) Redo the code generation but reusing temporaries.

(9+9)

7.

a) Explain the followings:
i) Loop-invariant code motion
ii) Dead-code elimination

b) What are the different storage allocation strategies? Explain in detail.

([2x6]+6)