

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 Σ , what do you mean by a language L over Σ ?
- 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 $(a,b) \in R$ 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.
 $M = (Q, \Sigma, \delta, q_0, F)$ where $Q = \{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7\}$, $\Sigma = \{0, 1\}$, $F = \{q_2\}$ and δ given as follows.

δ	0	1
q₀	q ₁	q ₅
q₁	q ₆	q ₂
q₂	q ₀	q ₂
q₃	q ₂	q ₆
q₄	q ₇	q ₅
q₅	q ₂	q ₆
q₆	q ₆	q ₄
q₇	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 $S \rightarrow AACD$, $A \rightarrow aAb \mid \epsilon$, $C \rightarrow aC \mid a$, $D \rightarrow aDa \mid bDb \mid \epsilon$.

(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:

$$A \rightarrow a A a$$
$$B \rightarrow b A b$$
$$A \rightarrow \epsilon$$

- 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 $E \rightarrow \text{const}$ 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)