

**COMPILER DESIGN
(INFO 3132)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

**Group - A
(Multiple Choice Type Questions)**

- Choose the correct alternative for the following: **10 × 1 = 10**
 - What is the output of lexical analyzer?

(a) A parse tree	(b) A list of tokens
(c) Intermediate code	(d) Machine code.
 - Definition of a language L with alphabet {a} is given as following. $L = \{a^n k \mid k > 0, \text{ and } n \text{ is a positive integer constant}\}$ What is the minimum number of states needed in a DFA to recognize L?

(a) $k + 1$	(b) $n + 1$	(c) $2n + 1$	(d) $2k + 1$.
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 - Recursive descent parsing is an example of

(a) top down parsing	(b) bottom up parsing
(c) predictive parsing	(d) none of the above.
 - The grammar $S \rightarrow aSa \mid bS \mid c$ is

(A) LL(1) but not LR(1)	(b) LR(1) but not LL(1)
(c) both LL(1) and LR(1)	(d) neither LL(1) nor LR(1).
 - The intersection of CFL (context free language) and RE (regular expression) is always

(a) CFL	(b) RE	(c) CSL	(d) both (a) and (c).
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 - Which of the following grammar rules violate the requirements of an operator grammar? P, Q, R are non-terminals, and r, s, t are terminals.

1. $P \rightarrow QR$	2. $P \rightarrow QsR$	3. $P \rightarrow \epsilon$	4. $P \rightarrow QtrR$
(a) 1 only	(b) 1 and 3 only		
(c) 2 and 3 only		(d) 3 and 4 only.	
 - A bottom up parser generates

(a) right most derivation	(b) right most derivation in reverse
(c) left most derivation	(d) left most derivation in reverse.

- Which of the following is true?

(a) $(01)^*0 = 0(10)^*$	
(b) $(0 + 1)^*0(0 + 1)^*1(0 + 1) = (0 + 1)^*01(0 + 1)^*$	
(c) $(0 + 1)^*01(0 + 1)^*+1^*0^* = (0 + 1)^*$	
(d) all of the above.	
- Which of the following is the most powerful parser?

(a) SLR	(b) Canonical LR
(c) Operator precedence	(d) LALR.
- Which is not included in activation record?

(a) Returned value	(b) Actual parameter
(c) Optional control link	(d) Formal parameter.

Group - B

- What is the difference between compiler and interpreter? Define assembler.
 - What is the output of lexical analyzer? Identify the tokens in the following statement:
int a, b, c;
a = (b + c);
 - What is regular definition? Write regular definition for the following tokens: if, then, else, relop, id and num.
- Write context free grammar (CFG) for the regular expression $r = (0 + 1)^*00(0 + 1)^*$.
 - Write regular expression for the set of all strings containing 1100 or 1010 as substring.
 - Write a regular expression (RE) for the set of strings whose 2nd bit from right end is 1 and 4th bit from right end is 0.

(3 + 1) + (1 + 2) + (1 + 4) = 12

5 + 3 + 4 = 12

Group - C

- Compute FIRST and FOLLOW of the following Grammar:
 $S \rightarrow 1AB \mid \epsilon$
 $A \rightarrow 1AC \mid 0C$
 $B \rightarrow 0S$
 $C \rightarrow 1$

- (b) Consider the following grammar,
 $G = (\{A, B\}, \{p, q, r, s\}, \{A \rightarrow rBs, B \rightarrow p|q\}, A)$, Show the steps of action taken by predictive parser program (PPP) for the sentence, $w = rps$,
 The predictive parsing table is given below:

	p	q	r	s	\$
A			$A \rightarrow rBs$		
B	$B \rightarrow p$	$B \rightarrow q$			

$$(3 + 3) + 6 = 12$$

5. (a) Find canonical set of LR(1) items, draw transition diagram and construct LALR parsing table for the following grammar:

$S \rightarrow AA$

$A \rightarrow aA|b$

- (b) Explain operator grammar with example.

$$(4 + 2 + 4) + 2 = 12$$

Group - D

6. (a) Define 3-address code with example. Write 3-address code for the following code fragment:

while $a > b * c$ OR $d < e * f$ AND $g > h$ do

if $a + b + c > d$ AND $b + c < a$ then

if $y < z$ then

$y = y + 1$;

else

$y = y - 1$;

else

$x = y - z / w$;

- (b) Define activation and activation tree with example.

- (c) Explain call by value and call by reference with example.

$$(2 + 5) + 3 + 2 = 12$$

7. (a) Consider the following code fragment, convert it to 3-address code then represent the 3-address code in quadruples and indirect triples:

$x = y + z + k$;

if $x > 10$ then

$x = y * z * k$;

else

$x = y + z - k$;

- (b) Consider the productions and its corresponding semantic rules in the following table, derive the sentence $5 * 5 + 4_n$ (n for new line) then draw the corresponding annotated parse tree.

	Production	Semantic Rules
1	$L \rightarrow E_n$	$\text{Print}(E.\text{val})$
2	$E \rightarrow E + T$	$E.\text{val} = E.\text{val} + T.\text{val}$
3	$E \rightarrow T$	$E.\text{val} = T.\text{val}$
4	$T \rightarrow T * F$	$T.\text{val} = T.\text{val} * F.\text{val}$
5	$T \rightarrow F$	$T.\text{val} = F.\text{val}$
6	$F \rightarrow (E)$	$F.\text{val} = E.\text{val}$
7	$F \rightarrow \text{digit}$	$F.\text{val} = \text{digit.lexval}$

$$(3 + 3) + (3 + 3) = 12$$

Group - E

8. (a) Define loop optimization with example.

- (b) Draw DAG for the following code fragment, then optimize the same:

1) $S1 = 4 * I$

2) $S2 = \text{addr}(A) - 4$

3) $S3 = S2[S1]$

4) $S4 = 4 * I$

5) $\text{Addr}(B) - 4$

6) $S6 = S5[S4]$

7) $S7 = S3 * S6$

8) $S8 = \text{PROD} + S7$

9) $\text{PROD} = S8$

10) $S9 = I + 1$

11) $I = S9$

12) if $I \leq 20$ goto (1)

$$3 + (6 + 3) = 12$$

9. Write short note (any three):

(i) Loop unrolling

(ii) Symbol table

(iii) Loop jamming

(iv) Peephole optimization

(v) Register allocation

(vi) Flow graphs.

$$(4 + 4 + 4) = 12$$