COMPILER DESIGN
(CSEN 4037)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) White spaces and tabs are removed in
(a) Lexical Analysis (b) Syntax Analysis
(c) Semantic Analysis (d) Code Optimization

(ii) Which of the following is an example of non-token in C?
(a) if (b) #ifdef (c) rate (d) none

(iii) A given grammar is not LL(1) if the parsing table of a grammar contains
(a) any blank field
(b) any Є-entry
(c) duplicate entry of same production
(d) more than one production rule in one table cell.

(iv) Given the grammar:
S → ABc
A→ a|Є
B→ b|Є
FOLLOW(A) is
(a) {$} (b) {b} (c) {b, c} (d) {a, b, c}

(v) If a grammar is LALR(1) then it is necessarily
(a) SLR(1) (b) LR(1) (c) LL(1) (d) None of the options.

(vi) A parse tree showing the values of attributes at each node is called
(a) Syntax Tree (b) Annotated Parse Tree
(c) Syntax Directed Parse Tree (d) Direct Acyclic Graph

(vii) Which of the following phase of compiler is an optional phase?
(a) Semantic analysis (b) Lexical analysis
(c) Intermediate code generation (d) Code optimization

(viii) Assume,
S1 = the number of states in SLR(1) parser
S2 = the number of states in LALR(1) parser
S3 = the number of states in CLR(1) parser, then which of the following is true?
(a) S1 = S2 = S3 (b) S1 = S2 ≤ S3
(c) S1 < S2 = S3 (d) S1 < S2 < S3

(ix) Which is used to keep track of currently active activations?
(a) Control stack (b) Activation record
(c) Execution record (d) Symbol table

(x) A common technique for improving the quality of generated code by examining a small, sliding window of instructions is called**:**
(a) Register allocation (b) Peephole optimization
(c) Live variable analysis (d) Intermediate code generation

Fill in the blanks with the correct word

(xi) A S-attributed grammar can be evaluated _____.

(xii) Machine independent optimization is applied on the code when it is in _____.

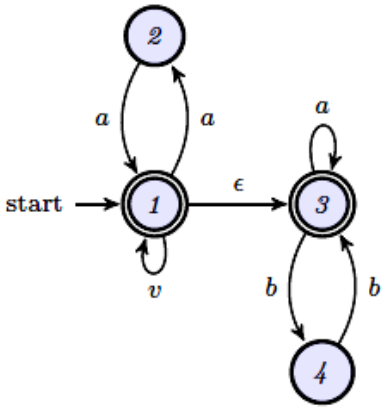
(xiii) _____ is a tree in which each leaf represents an operand and each interior node an operator.

(xiv) _____ is a top-down parser.

(xv) Characters are grouped into tokens in _____ phase of the compiler design.

Group - B

2. (a) What will be the regular expression of the given Finite state automata



[(CSEN4037.1, .5)(Apply/IOCQ)]

(b) Construct a deterministic finite automaton for the language over all binary strings that are divisible by 2 or 3. *[(CSEN4037.1, .2)(Apply/IOCQ)]*

6 + 6 = 12

3. (a) Draw corresponding DFA for the following:
(0|1)*0(0|1)(0|1)1 *[(CSEN4037.1, .2, .5)(Apply/IOCQ)]*

(b) Explain the different phases of a compiler showing the output of each phase. Use the example of the following statement: Y = A + B * 100. *[(CSEN4037.1, .2)(Apply/IOCQ)]*

3 + 9 = 12

Group - C

4. Consider the following grammar:
   $S \rightarrow aABb$
   $A \rightarrow c \mid \in$
   $B \rightarrow d \mid \in$
   (i) Prove the above grammar is LL(1)
   (ii) Draw the parsing table.
   (iii) Now check whether the string "***ab***" and "***acdb***" are the languages of the above grammar (Derive each step with the help of a stack). *[(CSEN4037.3, .4)(Apply/IOCQ)]*

   (3 + 5 + 4) = 12

5. (a) What is an activation record? Explain clearly the components of activation record. *[(CSEN4037.3)(Remember/LOCQ)]*

   (b) Consider the grammar:
   $S \rightarrow AS \mid b$
   $A \rightarrow SA \mid a$
   (i) Construct the SLR parsing table for this.
   (ii) Show all moves of parsing for the input "***abab***" *[(CSEN4037.3, .4)(Apply/IOCQ)]*

   4 + (4 + 4) = 12

Group - D

6. (a) Consider the two binary operators '↑' and '↓' with the precedence of operator ↓ being lower than that of the operator ↑. Operator ↑ is right associative while ↓ is left associative. Then what will be the parse tree for "**7 ↓ 3 ↑ 4 ↑ 3 ↓ 2**" *[(CSEN4037.4, .5)(Apply/IOCQ)]*

   (b) Translate the expression a = - (a + b) * (c + d) + (a + b + c) into
   (i) Quadruple (ii) Triple (iii) Indirect Triple *[(CSEN4037.4)(Understand/LOCQ)]*

   3 + (3 + 3 + 3) = 12

7. (a) Consider the following translation scheme:
   $S \rightarrow ER$
   $R \rightarrow *E$ {print ('*');}$R \mid \in$
   $E \rightarrow F + E$ {print ('+');} | F
   $F \rightarrow (S)$ | id {print (id.value);}
   For an input "**2 * 3 + 4**" this translation scheme prints_____? (*Explanation is required!!*) *[(CSEN4037.4)(Understand/LOCQ)]*

   (b) Generate the three address code for the below program fragment:

```
sum = 0;
for( i = 1; i <= 20; i++)
{
        c = 10
        sum = sum + i + c;
}
```

   [(CSEN4037.3, .4)(Apply/IOCQ)]

   (c) Define inherited attributes with suitable examples. *[(CSEN4037.3)(Remember/LOCQ)]*

   4 + 6 + 2 = 12

Group - E

8. (a) Translate the following code into machine code and show the register and address descriptors while the instructions are generated. Assume that two registers are available.

(i) x = y * z
(ii) w = p + y
(iii) y = y * z
(iv) p = w – x

[(CSEN4037.6)(Understand/LOCQ)]

(b) Design the control flow graph for the set of instructions given below:

1) i = 1
2) j = 1
3) t1 = 5 * i
4) t2 = t1 + j
5)t3 = 4 * t2
6) t4 = t3
7) a[t4] = -1
8) j = j + 1
9) if j <= 5 goto (3)
10) i = i + 1
11) if i < 5 goto (2)

[(CSEN4037.3, .4, .6)(Apply/IOCQ)]

6 + 6 = 12

9. Explain any ***three*** of the following techniques of code optimization with suitable examples:

(i) Copy propagation (ii) Dead code elimination
(iii) Code motion (iv) Common sub-expression elimination

[(CSEN4037.3, .6)(Remember/LOCQ)]

(4 + 4 + 4) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	38.54	61.46	0