SAMSKRUTI COLLEGE OF ENGINEERING & TECHNOLOGY

(Approved by AICTE, New Delhi & Affiliated to JNTUH.)

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Course Hand Out

Subject Name: COMPILER DESIGN

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UNIT -I

UNIT I INTRODUCTION TO COMPILER

1. What is a Complier?
A Complier is a program that reads a program written in one language-the source language-and translates it in to an equivalent program in another language-the target language . As an important part of this translation process, the compiler reports to its user the presence of errors in the source program

2. State some software tools that manipulate source program?
i. Structure editors
ii. Pretty printers
iii. Static
iv. checkers
v. Interpreters.

3. What are the cousins of compiler? April/May 2004, April/May 2005
The following are the cousins of
i. Preprocessors
ii.Assemblers
iii. Loaders
iv. Link editors.

4. What are the main two parts of compilation? What are they performing?
The two main parts are
• **Analysis** part breaks up the source program into constituent pieces and creates an intermediate representation of the source program.
• **Synthesis** part constructs the desired target program from the intermediate representation

5. What is a Structure editor?
A structure editor takes as input a sequence of commands to build a source program .The structure editor not only performs the text creation and modification functions of an ordinary text editor but it also analyzes the program text putting an appropriate hierarchical structure on the source program.

6. What are a Pretty Printer and Static Checker?

• A Pretty printer analyses a program and prints it in such a way that the structure of the program becomes clearly visible.

• A static checker reads a program, analyses it and attempts to discover potential bugs with out running the program.

7. How many phases does analysis consists?

Analysis consists of three phases

i .Linear analysis

ii. Hierarchical analysis

iii. Semantic analysis

8. What happens in linear analysis?

This is the phase in which the stream of characters making up the source program is read from left to right and grouped in to tokens that are sequences of characters having collective meaning.

9. What happens in Hierarchical analysis?

This is the phase in which characters or tokens are grouped hierarchically in to nested collections with collective meaning.

10. What happens in Semantic analysis?

This is the phase in which certain checks are performed to ensure that the components of a program fit together meaningfully.

11. State some compiler construction tools?Arpil /May 2008

i. Parse generator

ii. Scanner generators

iii. Syntax-directed translation engines

iv. Automatic code generator

v. Data flow engines.

12. What is a Loader? What does the loading process do?

A Loader is a program that performs the two functions

i. Loading

ii .Link editing

The process of loading consists of taking relocatable machine code, altering the relocatable address and placing the altered instructions and data in memory at the proper locations.

13. What does the Link Editing does?

Link editing: This allows us to make a single program from several files of relocatable machine code. These files may have been the result of several compilations, and one or more may be library files of routines provided by the system and available to any program that needs them.

14. What is a preprocessor?

A preprocessor is one, which produces input to compilers. A source program may be divided into modules stored in separate files. The task of collecting the source program is sometimes entrusted to a distinct program called a preprocessor.

The preprocessor may also expand macros into source language statements.

Skeletalsource program

Preprocessor

Source program

15. State some functions of Preprocessors

i) Macro processing
ii) File inclusion
iii) Relational Preprocessors
iv) Language extensions

16. What is a Symbol table?

A Symbol table is a data structure containing a record for each identifier, with fields for the attributes of the identifier. The data structure allows us to find the record for each identifier quickly and to store or retrieve data from that record quickly.

17. State the general phases of a compiler

i. Lexical analysis
ii. Syntax analysis
iii. Semantic analysis
iv. Intermediate code generation
v. Code optimization
vi. Code generation

18. What is an assembler?

Assembler is a program, which converts the source language in to assembly language.

19. What is the need for separating the analysis phase into lexical analysis and parsing? (Or) What are the issues of lexical analyzer?

• Simpler design is perhaps the most important consideration. The separation of lexical analysis from syntax analysis often allows us to simplify one or the other of these phases.
• Compiler efficiency is improved.
• Compiler portability is enhanced.

20. What is Lexical Analysis?

The first phase of compiler is Lexical Analysis. This is also known as linear analysis in which the stream of characters making up the source program is read from left-toright and grouped into tokens that are sequences of characters having a collective meaning.

21. What is a lexeme? Define a regular set. Nov/Dec 2006

• A Lexeme is a sequence of characters in the source program that is matched by the pattern for a token.
• A language denoted by a regular expression is said to be a regular set

22. What is a sentinel? What is its usage? April/May 2004

A Sentinel is a special character that cannot be part of the source program. Normally weuse ‘eof’ as the sentinel. This is used for speeding-up the lexical analyzer.

23. What is a regular expression? State the rules, which define regular expression?

Regular expression is a method to describe regular language
Rules:
1) ε-is a regular expression that denotes {ε} that is the set containing the empty string
2) If a is a symbol in Σ,then a is a regular expression that denotes {a}
3) Suppose r and s are regular expressions denoting the languages L(r) and L(s) Then,
a) (r)/(s) is a regular expression denoting L(r) U L(s).
b) (r)(s) is a regular expression denoting L(r)L(s)
c) (r)* is a regular expression denoting L(r)*.
d) (r) is a regular expression denoting L(r).

24. What are the Error-recovery actions in a lexical analyzer?

1. Deleting an extraneous character
2. Inserting a missing character
3. Replacing an incorrect character by a correct character
4. Transposing two adjacent characters

25. Construct Regular expression for the language

L= {w ε{a,b}/w ends in abb}

Ans: {a/b}*abb.

26. What is recognizer?

Recognizers are machines. These are the machines which accept the strings belonging to certain language. If the valid strings of such language are accepted by the machine then it is said that the corresponding language is accepted by that machine, otherwise it is rejected.

16 MARKS

1.PHASES OF COMPILER

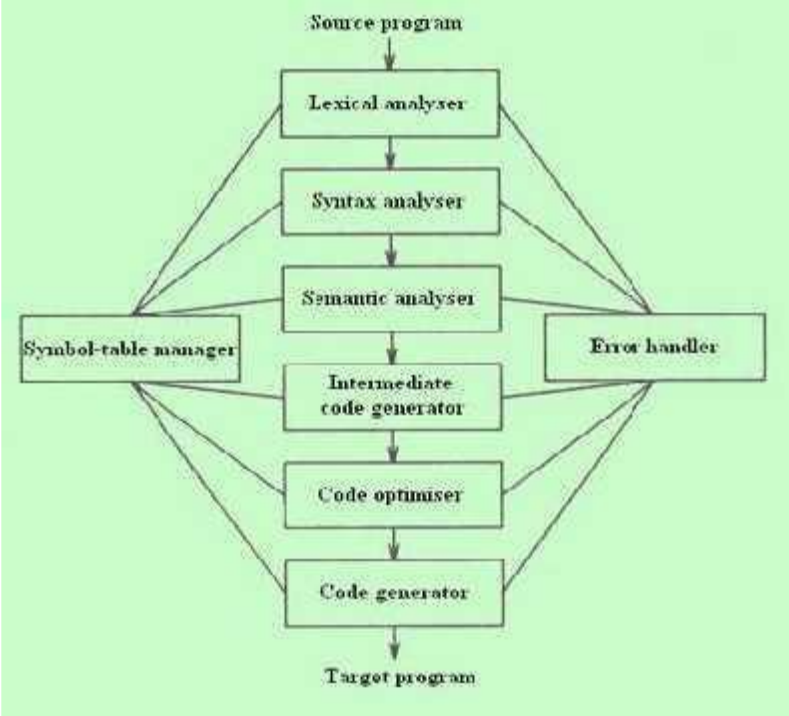
A Compiler operates in phases, each of which transforms the source program from one representation into another. The following are the phases of the compiler:

Main phases:

1) Lexical analysis
2) Syntax analysis
3) Semantic analysis
4) Intermediate code generation
5) Code optimization
6) Code generation

Sub-Phases:

1) Symbol table management
2) Error handling



LEXICAL ANALYSIS:

It is the first phase of the compiler. It gets input from the source program and produces tokens as output.

It reads the characters one by one, starting from left to right and forms the tokens.

Token : It represents a logically cohesive sequence of characters such as keywords,

- operators, identifiers, special symbols etc.
- Example: a + b = 20
- Here, a,b,+,=,20 are all separate tokens.
- Group of characters forming a token is called the **Lexeme**.

The lexical analyser not only generates a token but also enters the lexeme into the symbol

- table if it is not already there.

SYNTAX ANALYSIS:

It is the second phase of the compiler. It is also known as parser.

It gets the token stream as input from the lexical analyser of the compiler and generates

- syntax tree as the output.

Syntax tree:

- It is a tree in which interior nodes are operators and exterior nodes are operands.

Example: For a=b+c*2, syntax tree is

=

a +

b *

c 2

SEMANTIC ANALYSIS:

It is the third phase of the compiler.

It gets input from the syntax analysis as parse tree and checks whether the given syntax is correct or not.

It performs type conversion of all the data types into real data types.

INTERMEDIATE CODE GENERATION:

It is the fourth phase of the compiler.

It gets input from the semantic analysis and converts the input into output as intermediate code such as three
address code.

The three-address code consists of a sequence of instructions, each of which has atmost three operands.

Example: t1=t2+t3

CODE OPTIMIZATION:

It is the fifth phase of the compiler.

It gets the intermediate code as input and produces optimized intermediate code as output.

This phase reduces the redundant code and attempts to improve the intermediate code so that faster-running
machine code will result.

During the code optimization, the result of the program is not affected.

To improve the code generation, the optimization involves

- deduction and removal of dead code (unreachable code).
- calculation of constants in expressions and terms.
- collapsing of repeated expression into temporary string.
- loop unrolling.
- moving code outside the loop.
- removal of unwanted temporary variables.

CODE GENERATION:

It is the final phase of the compiler.

It gets input from code optimization phase and produces the target code or object code as result.

Intermediate instructions are translated into a sequence of machine instructions that perform the same task.

The code generation involves

- allocation of register and memory
- generation of correct references
- generation of correct data types
- generation of missing code

SYMBOL TABLE MANAGEMENT:

Symbol table is used to store all the information about identifiers used in the program.

It is a data structure containing a record for each identifier, with fields for the attributes of the identifier.

It allows to find the record for each identifier quickly and to store or retrieve data from
that record.

Whenever an identifier is detected in any of the phases, it is stored in the symbol table.

ERROR HANDLING:

Each phase can encounter errors. After detecting an error, a phase must handle the error so that compilation can
proceed.

In lexical analysis, errors occur in separation of tokens.

In syntax analysis, errors occur during construction of syntax tree.

In semantic analysis, errors occur when the compiler detects constructs with right syntactic structure but no meaning and during type conversion.

In code optimization, errors occur when the result is affected by the optimization.

In code generation, it shows error when code is missing etc.

2.COMPILER CONSTRUCTION TOOLS

These are specialized tools that have been developed for helping implement various phases of a compiler.

The following are the compiler construction tools:

1) **Parser Generators:**

-These produce syntax analyzers, normally from input that is based on a context-free grammar.

-It consumes a large fraction of the running time of a compiler.

-Example-YACC (Yet another Compiler-Compiler).

2) **Scanner Generator:**

-These generate lexical analyzers, normally from a specification based on regular expressions.

-The basic organization of lexical analyzers is based on finite automation.

3) **Syntax-Directed Translation:**

-These produce routines that walk the parse tree and as a result generate intermediate code.

-Each translation is defined in terms of translations at its neighbor nodes in the tree.

4) **Automatic Code Generators:**

-It takes a collection of rules to translate intermediate language into machine language. The rules must include
sufficient details to handle different possible access methods for data.

5) **Data-Flow Engines:**

-It does code optimization using data-flow analysis, that is, the gathering of information about how values are
transmitted from one part of a program to each other part.

UNIT-II LEXICAL ANALYSIS

2 MARKS

1. What is Lexical Analysis?

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Regular expression is a method to describe regular language

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3) Suppose r and s are regular expressions denoting the languages L(r) and L(s)
Then,
a) (r)/(s) is a regular expression denoting L(r) U L(s).
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6. Construct Regular expression for the language
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Ans: {a/b}*abb.
7. What is recognizer?
Recognizers are machines. These are the machines which accept the strings belonging to certain
language. If the valid strings of such language are accepted by the machine then it is said that the corresponding language is accepted by that machine, otherwise it is rejected.

8. Differentiate compiler and interpreter.
Compiler produces a target program whereas an interpreter performs the operations implied by the source program.
9. Write short notes on buffer pair.
Concerns with efficiency issues
Used with a lookahead on the input
It is a specialized buffering technique used to reduce the overhead required to process an input character. Buffer is divided into two N-character halves. Use two pointers. Used at times when the lexical analyzer needs to look ahead several characters beyond the lexeme for a pattern before a match is announced.
10. Differentiate tokens, patterns, lexeme.
Tokens- Sequence of characters that have a collective meaning.
Patterns- There is a set of strings in the input for which the same token is produced as output. This set of strings is described by a rule called a pattern associated with the token
Lexeme- A sequence of characters in the source program that is matched by the pattern for a token.
11. List the operations on languages.
Union - L U M ={s | s is in L or s is in M}

Concatenation − LM ={st | s is in L and t is in M}

Kleene Closure – L* (zero or more concatenations of L)
Positive Closure – L+ (one or more concatenations of L)

12. Write a regular expression for an identifier.

An identifier is defined as a letter followed by zero or more letters or digits.The regular expression for an identifier is given as **letter (letter | digit)***

13. Mention the various notational shorthands for representing regular expressions.

One or more instances (+)
Zero or one instance (?)
Character classes ([abc] where a,b,c are alphabet symbols denotes the regular expressions a | b | c.)
Non regular sets

14. What is the function of a hierarchical analysis?

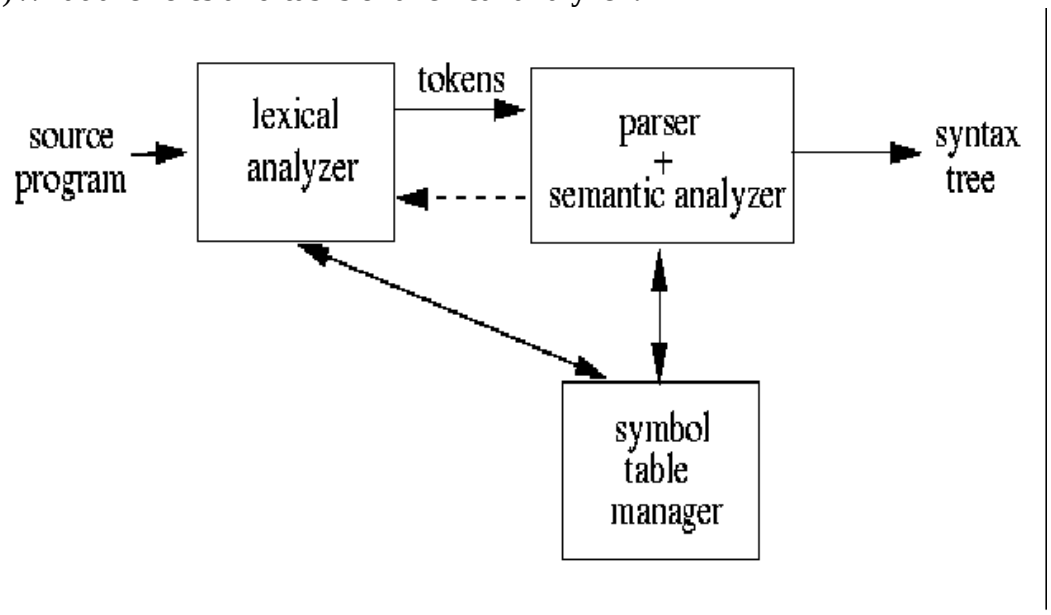
Hierarchical analysis is one in which the tokens are grouped hierarchically into nested collections with collective meaning. Also termed as Parsing.

15. What does a semantic analysis do?

Semantic analysis is one in which certain checks are performed to ensure that components of a program fit together meaningfully. Mainly performs type checking.

16 MARKS

1)**What are roles and tasks of a lexical analyzer?**



Main Task: Take a token sequence from the scanner and verify that it is a syntactically correct program.

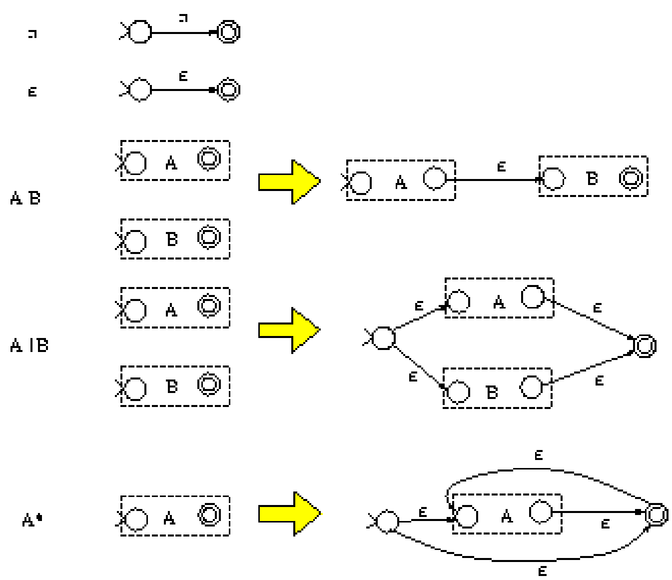
Secondary Tasks:

Process declarations and set up symbol table information accordingly, in preparation for

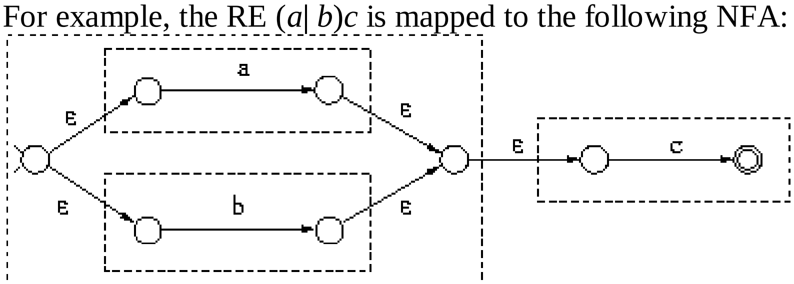
2. Converting a Regular Expression into a Deterministic Finite Automaton

The task of a scanner generator, such as JLex, is to generate the transition tables or to synthesize the scanner program given a scanner specification (in the form of a set of REs). So it needs to convert REs into a single DFA. This is accomplished in two steps: first it converts REs into a non-deterministic finite automaton (NFA) and then it converts the NFA into a DFA.

An NFA is similar to a DFA but it also permits multiple transitions over the same character and transitions over . In the case of multiple transitions from a state over the same character, when we are at this state and we read this character, we have more than one choice; the NFA succeeds if at least one of these choices succeeds. The transition doesn't consume any input characters, so you may jump to another state for free.
Clearly DFAs are a subset of NFAs. But it turns out that DFAs and NFAs have the same expressive power. The problem is that when converting a NFA to a DFA we may get an exponential blowup in the number of states.
We will first learn how to convert a RE into a NFA. This is the easy part. There are only 5 rules, one for each type of RE:

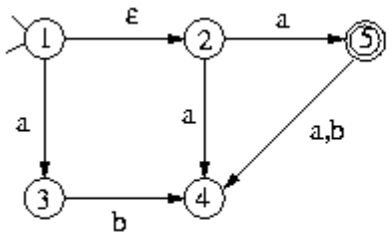


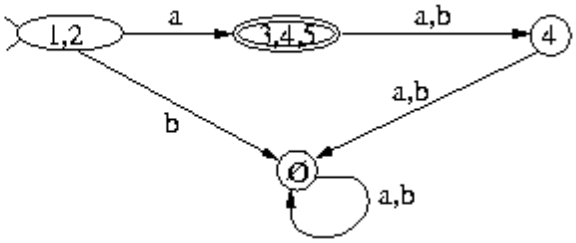
As it can been shown inductively, the above rules construct NFAs with only one final state. For example, the third rule indicates that, to construct the NFA for the RE *AB*, we construct the NFAs for *A* and *B*, which are represented as two boxes with one start state and one final state for each box. Then the NFA for *AB* is constructed by connecting the final state of *A* to the start state of *B* using an empty transition.
For example, the RE (*a*| *b*)*c* is mapped to the following NFA:



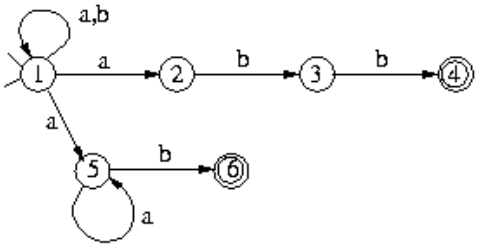
The next step is to convert a NFA to a DFA (called *subset construction*). Suppose that you assign a number to each NFA state. The DFA states generated by subset construction have sets of numbers, instead of just one number. For example, a DFA state may have been assigned the set {5, 6, 8}. This indicates that arriving to the state labeled {5, 6, 8} in the DFA is the same as

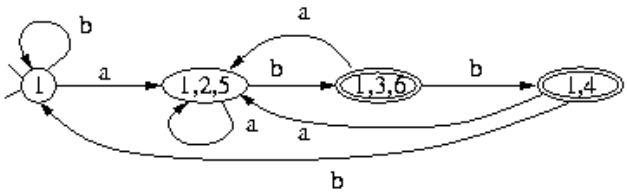
arriving to the state 5, the state 6, or the state 8 in the NFA when parsing the same input. (Recall that a particular input sequence when parsed by a DFA, leads to a unique state, while when parsed by a NFA it may lead to multiple states.)
First we need to handle transitions that lead to other states for free (without consuming any input). These are the transitions. We define the *closure* of a NFA node as the set of all the nodes reachable by this node using zero, one, or more transitions.
For example, The closure of
node 1 in the left figure below





is the set {1, 2}. The start state of the constructed DFA is labeled by the closure of the NFA start state. For every DFA state labeled by some set {s_1,..., s_n} and for every character *c* in the language alphabet, you find all the states reachable by s_1, s_2, ..., or s_n using *c* arrows and you union together the closures of these nodes. If this set is not the label of any other node in the DFA constructed so far, you create a new DFA node with this label. For example, node {1, 2} in the DFA above has an arrow to a {3, 4, 5} for the character *a* since the NFA node 3 can be reached by 1 on *a* and nodes 4 and 5 can be reached by 2. The *b* arrow for node {1, 2} goes to the error node which is associated with an empty set of NFA nodes.
The following NFA recognizes (*a*| *b*)*(*abb* | *a*+*b*), even though it wasn't constructed with the above RE-to-NFA rules. It has the following DFA:





UNIT III SYNTAX ANALYSIS

1. Define parser.
Hierarchical analysis is one in which the tokens are grouped hierarchically into nested collections with collective meaning.
Also termed as Parsing.
2. Mention the basic issues in parsing.

There are two important issues in parsing.
Specification of syntax
Representation of input after parsing.

3. **Why lexical and syntax analyzers are separated out?**

Reasons for separating the analysis phase into lexical and syntax analyzers:
Simpler design.
Compiler efficiency is improved.
Compiler portability is enhanced.

4. **Define a context free grammar.**

A context free grammar G is a collection of the following
V is a set of non terminals
T is a set of terminals
S is a start symbol
P is a set of production rules
G can be represented as G = (V,T,S,P)
Production rules are given in the following form
Non terminal → (V U T)*

5. **Briefly explain the concept of derivation.**

Derivation from S means generation of string w from S. For constructing derivation two things are important.
i) Choice of non terminal from several others.
ii) Choice of rule from production rules for corresponding non terminal.
Instead of choosing the arbitrary non terminal one can choose
i) either leftmost derivation – leftmost non terminal in a sentinel form
ii) or rightmost derivation – rightmost non terminal in a sentinel form

6. **Define ambiguous grammar.**

A grammar G is said to be ambiguous if it generates more than one parse tree for some sentence of language L(G).
i.e. both leftmost and rightmost derivations are same for the given sentence.

7. **What is a operator precedence parser?**

A grammar is said to be operator precedence if it possess the following properties:
1. No production on the right side is ε.
2. There should not be any production rule possessing two adjacent non terminals at the right hand side.

8. **List the properties of LR parser.**

1. LR parsers can be constructed to recognize most of the programming languages for which the context free grammar can be written.
2. The class of grammar that can be parsed by LR parser is a superset of class of grammars that can be parsed using predictive parsers.
3. LR parsers work using non backtracking shift reduce technique yet it is efficient one.

9. **Mention the types of LR parser.**

SLR parser- simple LR parser
LALR parser- lookahead LR parser

Canonical LR parser

10. **What are the problems with top down parsing?**

The following are the problems associated with top down parsing:

Backtracking

Left recursion

Left factoring

Ambiguity

11. **Write the algorithm for FIRST and FOLLOW.**

FIRST

1. If X is terminal, then FIRST(X) IS {X}.
2. If X → ε is a production, then add ε to FIRST(X).
3. If X is non terminal and X → Y1,Y2..Yk is a production, then place a in FIRST(X) if for some i , a is in FIRST(Yi) , and ε is in all of FIRST(Y1),…FIRST(Yi-1);

FOLLOW

1. Place $ in FOLLOW(S),where S is the start symbol and $ is the input right endmarker.
2. If there is a production A → αBβ, then everything in FIRST(β) except for ε is placed in FOLLOW(B).
3. If there is a production A → αB, or a production A→ αBβ where FIRST(β) contains ε , then everything in FOLLOW(A) is in FOLLOW(B).

12. **List the advantages and disadvantages of operator precedence parsing.**

Advantages

This typeof parsing is simple to implement.

Disadvantages

1. The operator like minus has two different precedence(unary and binary).Hence it is hard to handle tokens like minus sign.
2. This kind of parsing is applicable to only small class of grammars.

13. **What is dangling else problem?**

Ambiguity can be eliminated by means of dangling-else grammar which is show below:

stmt → if expr then stmt

| if expr then stmt else stmt

| other

14. **Write short notes on YACC.**

YACC is an automatic tool for generating the parser program.

YACC stands for Yet Another Compiler Compiler which is basically the utility available from UNIX.

Basically YACC is LALR parser generator.

It can report conflict or ambiguities in the form of error messages.

15. **What is meant by handle pruning?**

A rightmost derivation in reverse can be obtained by handle pruning.

If w is a sentence of the grammar at hand, then w = γn, where γn is the nth rightsentential form of some as yet unknown rightmost derivation

S = γ0 => γ1…=> γn-1 => γn = w

16. **Define LR(0) items.**
An LR(0) item of a grammar G is a production of G with a dot at some position of the right side. Thus, production A → XYZ yields the four items
A→**.**XYZ
A→X**.**YZ
A→XY**.**Z
A→XYZ**.**
17. **What is meant by viable prefixes?**
The set of prefixes of right sentential forms that can appear on the stack of a shift-reduce parser are called viable prefixes. An equivalent definition of a viable prefix is that it is a prefix of a right sentential form that does not continue past the right end of the rightmost handle of that sentential form.
18. **Define handle.**
A handle of a string is a substring that matches the right side of a production, and whose reduction to the nonterminal on the left side of the production represents one step along the reverse of a rightmost derivation.
A handle of a right – sentential form γ is a production A→β and a position of γ where the string β may be found and replaced by A to produce the previous right-sentential form in a rightmost derivation of γ. That is , if S =>αAw =>αβw,then A→β in the position following α is a handle of αβw.
19. **What are kernel & non-kernel items?**
Kernel items, whish include the initial item, S'→ **.**S, and all items whose dots are not at the left end.
Non-kernel items, which have their dots at the left end.
20. **What is phrase level error recovery?**
Phrase level error recovery is implemented by filling in the blank entries in the predictive parsing table with pointers to error routines. These routines may change, insert, or delete symbols on the input and issue appropriate error messages. They may also pop from the stack.

PART B
1) Construct a predictive parsing.table for the grammar
E -> E + T / F
T -> T * F / F
F -> (E) / id
2) Give the LALR parsing table for the grammar.
S -> L = R / R
L -> * R / id
R -> L
3) Consider the grammar

E -> TE’
E’ -> + TE’ / E
T -> FT’
T’ -> *FT’ / E
F -> (E) / id
Construct a predictive parsing table for the grammar shown above. Verify whether the input string
id + id * id is accepted by the grammar or not.
4) Consider the grammar.
E -> E + T
E -> T
T -> T * F
T -> F
F -> (E) / id
Construct an LR parsing table for the above grammar. Give the moves of the LR parser on
id * id + id
5) For the grammar given below, calculate the operator precedence relation and

the precedence functions
E -> E + E | E – E |
| E * E | E | E |
| E ^ E | (E) |
| -E | id
6) Compare top down parsing and bottom up parsing methods.
7) What are LR parsers? Explain with a diagram the LR parsing algorithm.
8) What are parser generators?
9) Explain recursive descent parser with appropriate examples.
10) Compare SLR, LALR and LR parses.

UNIT IV - SYNTAX DIRECTED TRANSLATION & RUN TIME ENVIRONMENT

1. List the different storage allocation strategies.
The strategies are:
Static allocation
Stack allocation
Heap allocation
2. What are the contents of activation record?
The activation record is a block of memory used for managing the information needed by a single execution of a procedure. Various fields f activation record are:

Temporary variables
Local variables
Saved machine registers
Control link
Access link
Actual parameters
Return values

3. What is dynamic scoping?

In dynamic scoping a use of non-local variable refers to the non-local data declared in most recently called and still active procedure. Therefore each time new findings are set up for local names called procedure. In dynamic scoping symbol tables can be required at run time.

4. Define symbol table.

Symbol table is a data structure used by the compiler to keep track of semantics of the variables. It stores information about scope and binding information about names.

5. What is code motion?

Code motion is an optimization technique in which amount of code in a loop is decreased. This transformation is applicable to the expression that yields the same result independent of the number of times the loop is executed. Such an expression is placed before the loop.

6. What are the properties of optimizing compiler?

The source code should be such that it should produce minimum amount of target code.
There should not be any unreachable code.
Dead code should be completely removed from source language.
The optimizing compilers should apply following code improving transformations on source language.
i) common subexpression elimination
ii) dead code elimination
iii) code movement
iv) strength reduction

7. What are the various ways to pass a parameter in a function?

Call by value
Call by reference
Copy-restore
Call by name

8. Suggest a suitable approach for computing hash function.

Using hash function we should obtain exact locations of name in symbol table.
The hash function should result in uniform distribution of names in symbol table.
The hash function should be such that there will be minimum number of collisions.
Collision is such a situation where hash function results in same location for storing the names.

9. Define bottom up parsing?

It attempts to construct a parse tree for an input string is beginning at leaves and working up towards the root (i.e.) reducing a string „w" to the start symbol of a grammar. At each reduction step, a particular substring matching the right side of a production is replaced by the symbol on the left of that production. It is a rightmost derivation and it" s also known as shifts reduce parsing.

10. What are the functions used to create the nodes of syntax trees?

- Mknode (op, left, right)
- Mkleaf (id,entry)
- Mkleaf (num, val)

11. What are the functions for constructing syntax trees for expressions?

i) The construction of a syntax tree for an expression is similar to the translation of the expression into postfix form.

ii) Each node in a syntax tree can be implemented as a record with several fields.

12. Give short note about call-by-name?

Call by name, at every reference to a formal parameter in a procedure body the name of the corresponding actual parameter is evaluated. Access is then made to the effective parameter.

13. How parameters are passed to procedures in call-by-value method?

This mechanism transmits values of the parameters of call to the called program. The transfer is one way only and therefore the only way to returned can be the value of a function.

```
Main ( )
{ print (5);
} Int
Void print (int n)
{ printf (“%d”, n); }
```

14. Define static allocations and stack allocations

Static allocation is defined as lays out for all data objects at compile time.

Names are bound to storage as a program is compiled, so there is no need for a run time support package.

Stack allocation is defined as process in which manages the run time as a Stack. It is based on the idea of a control stack; storage is organized as a stack, and activation records are pushed and popped as activations begin and end.

15. What are the difficulties with top down parsing?

a) Left recursion

b) Backtracking

c) The order in which alternates are tried can affect the language accepted

d) When failure is reported. We have very little idea where the error actually occurred.

16. Define top down parsing?

It can be viewed as an attempt to find the left most derivation for an input string. It can be viewed as attempting to construct a parse tree for the input starting from the root and creating the nodes of the parse tree in preorder.

17. Define a syntax-directed translation?

Syntax-directed translation specifies the translation of a construct in terms of Attributes associated with its syntactic components. Syntax-directed translation uses a context free grammar to specify the syntactic structure of the input. It is an input- output mapping.

18. Define an attribute. Give the types of an attribute?

An attribute may represent any quantity, with each grammar symbol, it associates a set of attributes and with each production, a set of semantic rules for computing values of the attributes associated with the symbols appearing in that production.

Example: a type, a value, a memory location etc.,

i) Synthesized attributes.

ii) Inherited attributes.

19. Give the 2 attributes of syntax directed translation into 3-addr code?

i) E.place, the name that will hold the value of E and

ii) E.code , the sequence of 3-addr statements evaluating E.

20. Write the grammar for flow-of-control statements?

The following grammar generates the flow-of-control statements, if-then, ifthen-else, and while-do statements.

S -> if E
then S1
| If E then S1
else S2
| While E do S1.

PART B

1) Discuss in detail about the run time storage arrangement.
2) What are different storage allocation strategies. Explain.
3) Write in detail about the issues in the design of code generator.
4) Explain how declarations are done in a procedure using syntax directed translations.
5) What is a three address code? Mention its types. How would you implement these address statements? Explain with suitable examples.
6) Write syntax directed translation for arrays.

UNIT V CODE OPTIMISATION AND CODE GENERATION

1. Define code generations with ex?

It is the final phase in compiler model and it takes as an input an intermediate representation of the source program and output produces as equivalent target programs. Then intermediate instructions are each translated into a sequence of machine instructions that perform the same task.

2. What are the issues in the design of code generator?

Input to the generator

Target programs
Memory management
Instruction selection
Register allocation
Choice of evaluation order
Approaches to code generation.

3. Give the variety of forms in target program.

Absolute machine language.
Relocatable machine language.
Assembly language.

4. Give the factors of instruction selections.

Uniformity and completeness of the instruction sets
Instruction speed and machine idioms
Size of the instruction sets.

5. What are the sub problems in register allocation strategies?

During register allocation, we select the set of variables that will reside in register at a point in the program.
During a subsequent register assignment phase, we pick the specific register that a variable reside in.

6. Give the standard storage allocation strategies.

Static allocation
Stack allocation.

7. Define static allocations and stack allocations

Static allocation is defined as lays out for all data objects at compile time. Names are bound to storage as a program is compiled, so there is no need for a Run time support package.
Stack allocation is defined as process in which manages the run time as a Stack. It is based on the idea of a control stack; storage is organized as a stack, And activation records are pushed and popped as activations begin and end.

8. **Write the addressing mode and associated costs in the target machine.**

MODE	FORM	ADDRESS	ADDED COST
Absolute	M	M	1
Register	R	R	0
Indexed	c(R)	c+contents(R)	1
Indirect register	*R	contents(R)	0
Indirect indexed	*c(R)	contents(c+contents (R))	1

9. Define basic block and flow graph.

A basic block is a sequence of consecutive statements in which flow of Control enters at the beginning and leaves at the end without halt or possibility Of branching except at the end.
A flow graph is defined as the adding of flow of control information to the Set of basic blocks making up a program by constructing a directed graph.

10. Write the step to partition a sequence of 3 address statements into basic blocks.

1. First determine the set of leaders, the first statement of basic blocks.
The rules we can use are the following.
The first statement is a leader.
Any statement that is the target of a conditional or unconditional goto is a leader.
Any statement that immediately follows a goto or conditional goto statement is a leader.
2. For each leader, its basic blocks consists of the leader and all statements
Up to but not including the next leader or the end of the program.

11. Give the important classes of local transformations on basic blocks

Structure preservation transformations
Algebraic transformations.

12. Describe algebraic transformations.

It can be used to change the set of expressions computed by a basic blocks into A algebraically equivalent sets. The useful ones are those that simplify the Expressions place expensive operations by cheaper ones.
X = X+ 0
X = X * 1

13. What is meant by register descriptors and address descriptors?

A register descriptor keeps track of what is currently in each register. It is Consulted whenever a new register is needed.
An address descriptor keeps track of the location where ever the current Value of the name can be found at run time. The location might be a register, a Stack location, a memory address,

14. What are the actions to perform the code generation algorithms?

Invoke a function get reg to determine the location L.

Consult the address descriptor for y to determine y", the current location of y.

If the current values of y and/or z have no next uses, are not live on exit from the block, and are in register, alter the register descriptor.

15. Write the code sequence for the d:=(a-b)+(a-c)+(a-c).

Statement	Code generation	Register descriptor	Address descriptor
t:=a-b	MOV a,R0 SUB b,R0	R0 contains t	t in R0
u:=a-c	MOV a,R1 SUB c,R1	R0 contains t R1 contains u	t in R0 u in R1
v:=t+u	ADD R1,R0	R0 contains v R1 contains u	u in R1 v in R0
d:=v+u	ADD R1,R0 MOV R0,d	R0 contains d	d in R0 d in R0 and memory

16. Write the labels on nodes in DAG.

A DAG for a basic block is a directed acyclic graph with the following Labels on nodes:
Leaves are labeled by unique identifiers, either variable names or constants.
Interior nodes are labeled by an operator symbol.
Nodes are also optionally given a sequence of identifiers for labels.

17. Give the applications of DAG.

Automatically detect the common sub expressions
Determine which identifiers have their values used in the block.
Determine which statements compute values that could be used outside the blocks.

18. Define Peephole optimization.

A Statement by statement code generation strategy often produces target code that contains redundant instructions and suboptimal constructs. “Optimizing” is misleading because there is no guarantee that the resulting code is optimal. It is a method for trying to improve the performance of the target program by examining the short sequence of target instructions and replacing this instructions by shorter or faster sequence.

19. Write the characteristics of peephole optimization?

Redundant-instruction elimination
Flow-of-control optimizations.
Algebraic simplifications
Use of machine idioms

20. What are the structure preserving transformations on basic blocks?

Common sub-expression elimination
Dead-code elimination
Renaming of temporary variables
Interchange of two independent adjacent statement

21. Define Common sub-expression elimination with ex.

It is defined as the process in which eliminate the statements which has the Same expressions. Hence this basic block may be transformed into the equivalent Block.

Ex:

a : =b + c b
:=a - d
c :=b + c

After elimination:

a : =b + c b
:=a - d
c :=a

22. Define Dead-code elimination with ex.

It is defined as the process in which the statement x=y+z appear in a basic block, where x is a dead that is never subsequently used. Then this statement maybe safely removed without changing the value of basic blocks.

23. Define Renaming of temporary variables with ex.

We have the statement u:=b + c ,where u is a new temporary variable, and change all uses of this instance of t to u, then the value of the basic block is not changed.

24. Define reduction in strength with ex.

Reduction in strength replaces expensive operations by equivalent cheaper ones on the target machines. Certain machine instructions are cheaper than others and can often be used as special cases of more expensive operators. Ex:

X^2 is invariably cheaper to implement as x*x than as a call to an exponentiation routine.

25. Define use of machine idioms.

The target machine may have harder instructions to implement certain specific operations efficiently. Detecting situations that permit the use of these instructions can reduce execution time significantly.

26. Define code optimization and optimizing compiler

The **term code-optimization** refers to techniques a compiler can employ in an attempt to produce a better object language program than the most obvious for a given source program. Compilers that apply code-improving transformations are called **Optimizing-compilers.**

PART B:

1. What are the issues in the design of code generator? Explain in detail.
2. Discuss about the run time storage management.
3. Explain basic blocks and flow graphs.
4. Explain about transformation on a basic block.
5. Write a code generation algorithm. Explain about the descriptor and function getreg().Give an example.
6. Explain peephole optimization
7. Explain DAG representation of basic blocks.
8. Explain principle sources of code optimization in details.
9. Explain the Source language issues with details.
10. Explain the Storage organization strategies with examples.
11. Explain storage allocation strategy.
12. Explain about Parameter passing.
13. Explain the non local names in runtime storage managements.
14. Explain about activation records and its purpose.
15. Explain about Optimization of basic blocks.
16. Explain the various approaches to compiler development.
17. Explain simple code generator with suitable example.
18. Discuss about the following:

a) Copy Propagation b) Dead-code Elimination and c) Code motion