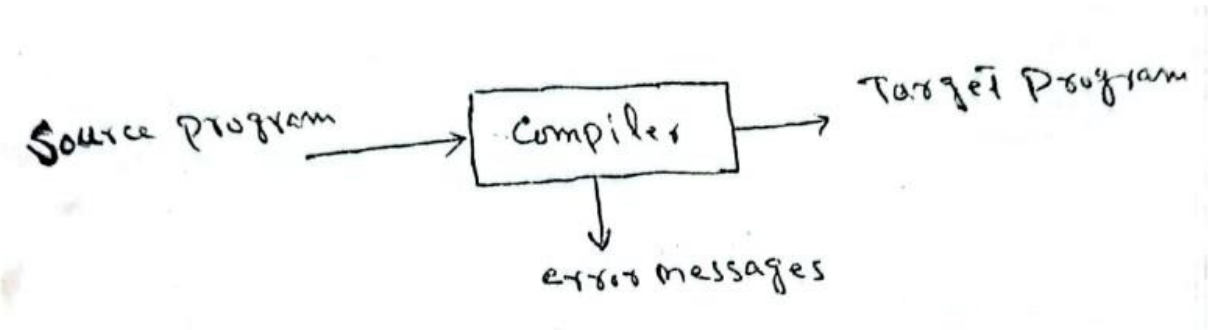
COMPILER CONSTRUCTION NOTES

CS-603

Compiler:



- Target program can be in any language.
- Translator Program

Compiler classified on the basis of purpose:

- Single-pass
- Multi-pass
- Debugging
- Optimizing

Analysis-Synthesis Model of Compiler:

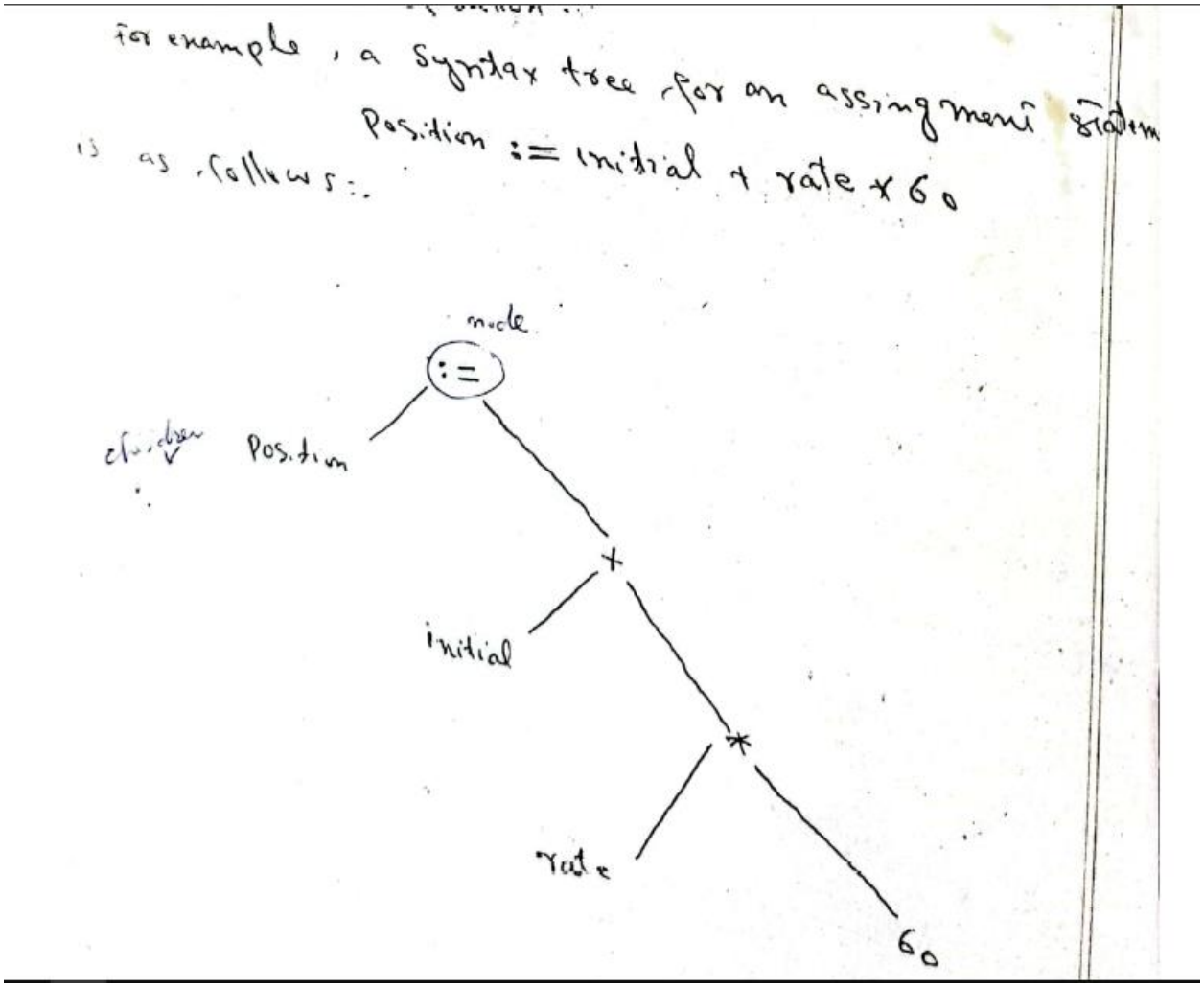
Two parts of compilation:

- **Analysis**
  Divide source program into pieces and convert into intermediate representation
- **Synthesis**
  Convert intermediate representation to target program

Analysis:

- Converts source program into hierarchical structure called **Syntax Tree** where **node** represents **operations** and **children** of nodes represents **arguments**.

Example:



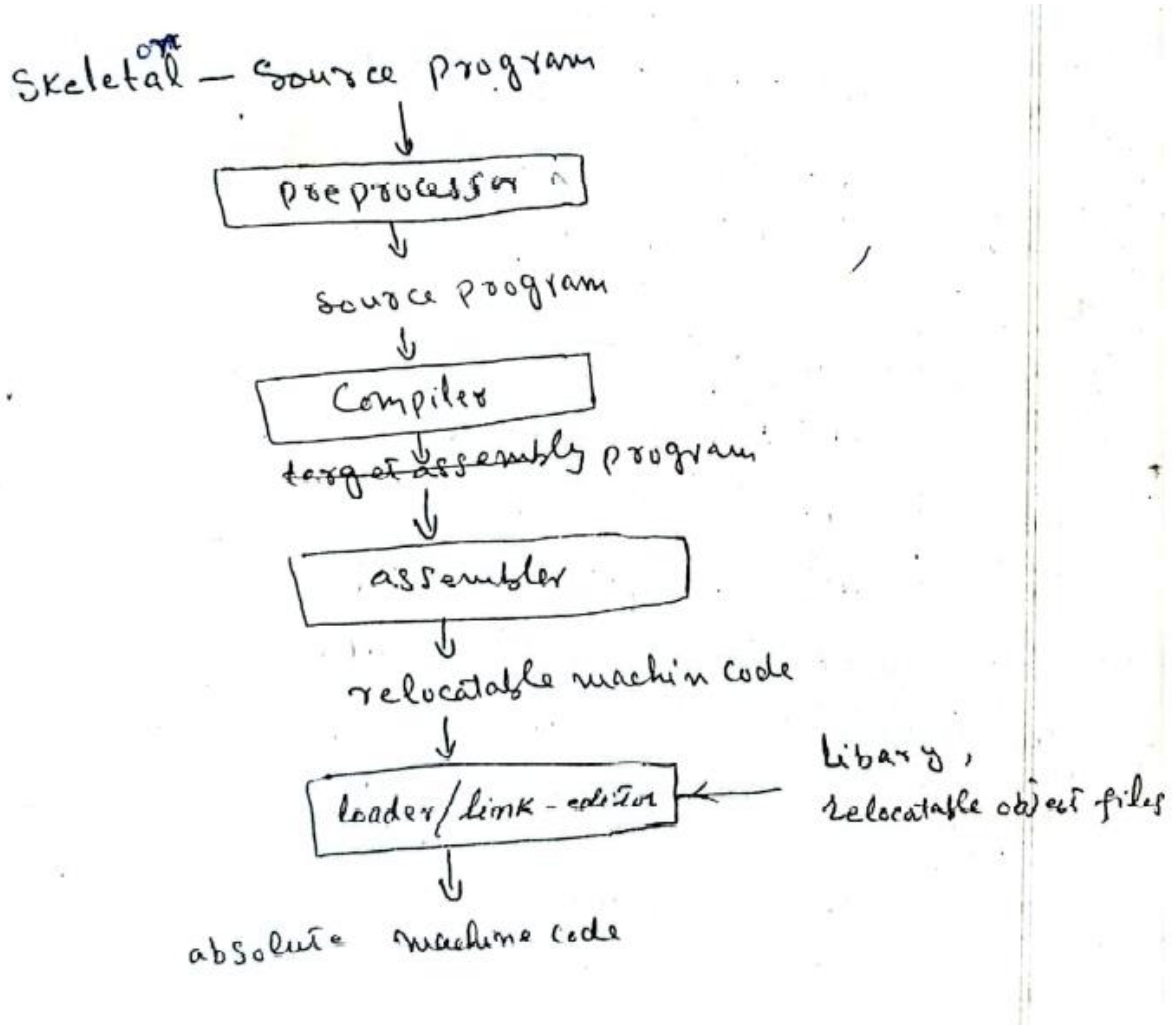
Tools which perform the analysis of source program:

- **Structure Editors**
  - Text Creation and Manipulation
  - Put appropriate hierarchical structure to the source program
  - Also supply reminder keywords
  - **E.g.,** Provides hints of keywords while writing code
- **Pretty Printers**
  - Analyze program and print it in clearly visible structure
  - **E.g.,** Comments showed in different colour and code with indentation
- **Static Checkers**
  - Detects bugs related to running of program
  - **E.g.,** A variable used before defining will result in error

- **Interpreters**
  - Instead of translating, performs operations implied by source program
  - It calls routines to perform operations

The Context of a Compiler:

- In additions to compiler, other programs are also used to create executable target program.



- **Preprocessor**
  - Collection of source program (if consists of modules (multiple files))
  - Expand macros (short hands) into source language statements
- **Compiler**
  - Creates assembly code of source program

- **Assembler**
  - Translates assembly code into machine code and attach some library routines

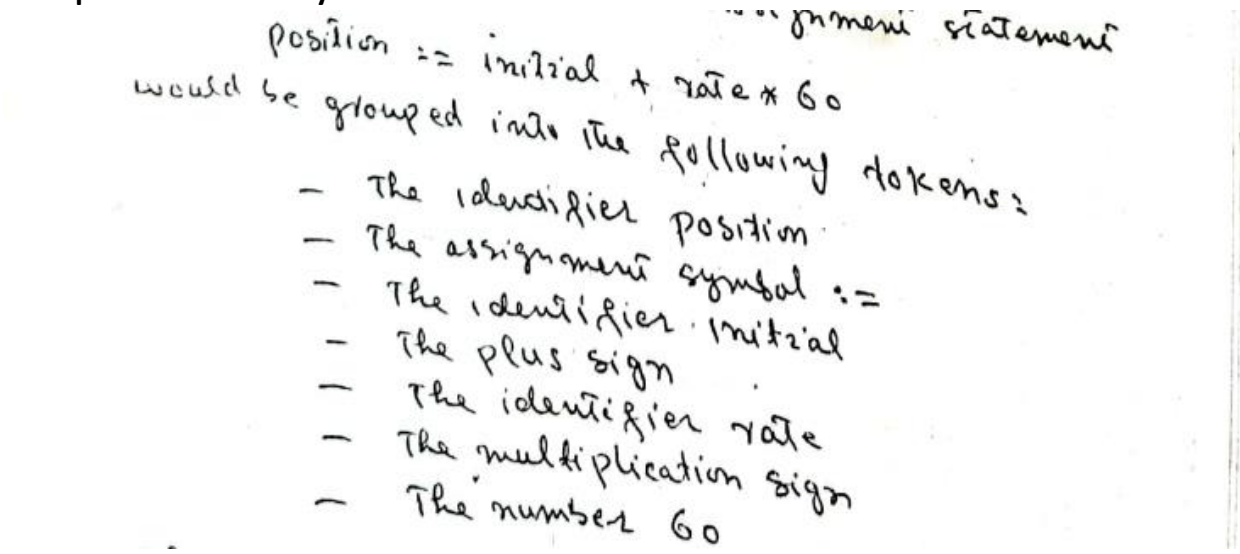
Analysis of Source Program:

In compiling, Analysis consists of **three** phases:

- **Linear Analysis**
  - Stream of characters making source program read from left to right and grouped into tokens (sequences of characters that have a collected meaning)
- **Hierarchical Analysis**
  - Character / Tokens are grouped into hierarchically into nested collections
- **Semantic Analysis**
  - Certain checks to ensure that components of program fits together meaningfully

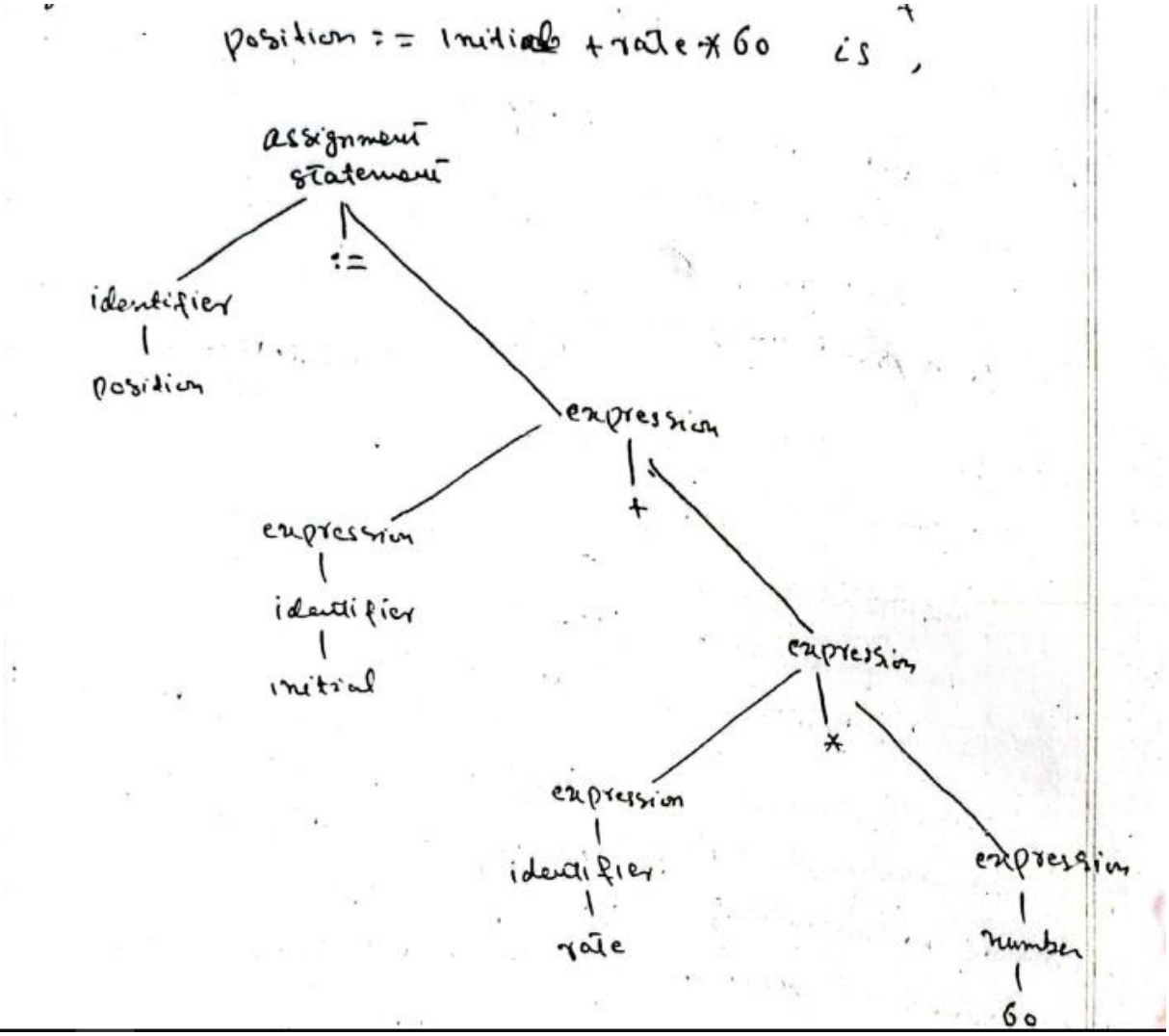
Lexical Analysis:

- In compiler:
  Lexical Analysis = Linear Analysis = Scanning
- **Example of Lexical Analysis:**



Syntax Analysis:

- Hierarchical Analysis = Syntax Analysis = Parsing
- Grouping the tokens of source program into grammatical phrases that are used by complier to synthesize the output
- Grammatical Phrases usually represented by parse tree



- Hierarchical structure of program usually represented by **recursive rules**
  Examples:
  Non-recursive Rules:
  - Any identifier is an expression.

  Recursive Rules:

  - If **identifier1** is an identifier and **expression2** is an expression, then
    Identifier1 := Expression2
    Is a statement
- The division between lexical and syntax analysis is often arbitrary. One is used which simplifies the task of analysis.

- Division is often determined by whether the source language construct is inherently recursive or not.
    - Lexical Analysis -> non-recursive
    - Syntax Analysis -> recursive

Semantic Analysis:

- Checks for semantic (logical) errors
- Gather type information for code-generation phase
- Use parse tree (from syntax analysis) to identify operators and operands of expressions and statements
- Perform type checking
    - Complier will report an error if a real number is used to index an array

The Phases of Compiler:

- A complier operates in phases where each phase transforms the source program from one representation to another

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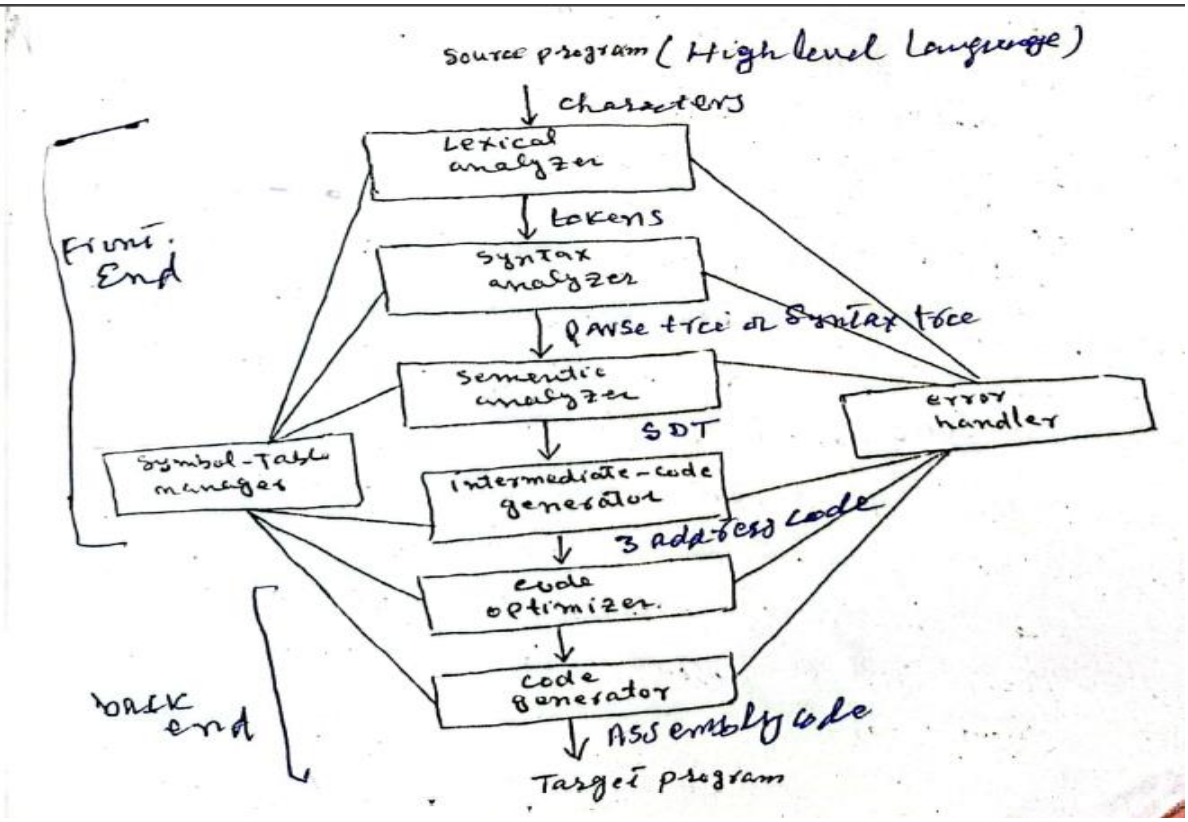

Symbol-Table Management:

- A symbol-table is a data structures which contains the record for each identifier, with fields for attributes.
- Lexical analyzer only put the identifier in the syntax-table not it's attributes
  - Attributes -> provides info about the storage, type and scope of identifier. In case of procedure names, it provides info about number and type of arguments.
- The remaining phases enter explanation about the identifier in symbol table.

Error Detection & Reporting:

- Syntax and Semantic Analysis phases usually handle a large fraction of errors detectable by compiler.
- Syntax Analysis handles syntax errors.
  - The token which violates the structure rule defined in the language.
- Semantic Analysis handles logical errors.
  - Syntax is right but no meaningful operation is involved
  - Example:
    - Addition of an array and a procedure