Systems Programming

Final Project – SIC/XE Assembler

Phase 2

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➢ Requirements Specifications:

Implementing pass 2 of two pass SIC/XE assembler by building on the previous phase:

The output of this phase is:

- The Object-Code file.
- The program code with each line ended with its object code.
- A report with all errors in both pass1 and pass2.

The program supports:

- EQU and ORG statements.
- Simple expressions evaluation.

❖ Extra Features:

1. The program deals with literals.

➢ Design:

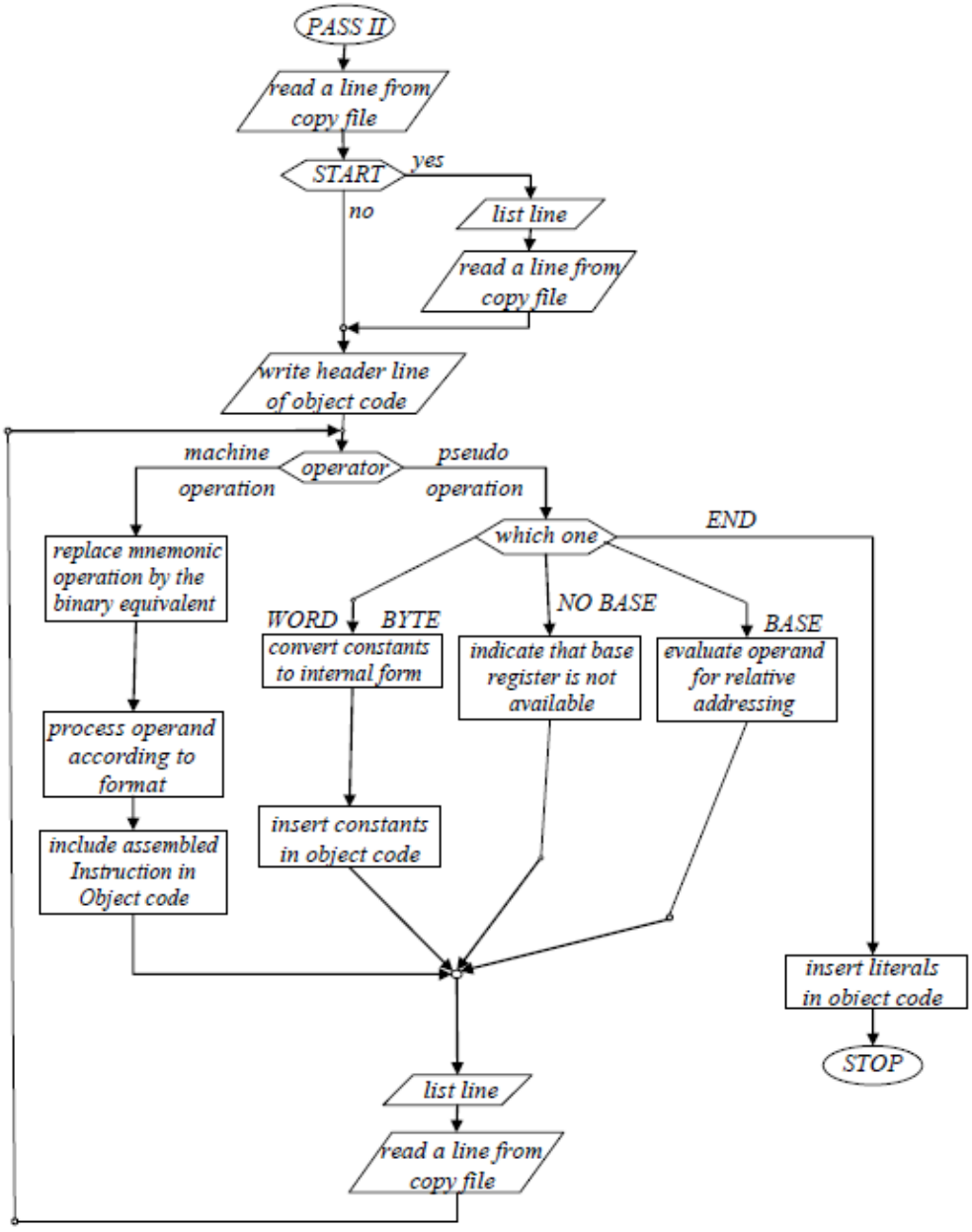
<u>In addition to previously mentioned classes and the overall design and flow of source code, there are 4 other classes:</u>

- **Class Parser_phase2:**
  To parse each line of pass 1 output and get the operation codes and operands and send these parameters to ObjectCode class
- **Class ObjectCode:**
  Generate object code for each line by calculating addresses.
- **Class ObjectFile:**
  Generate different records for the object file and print them as an output of pass 2.
- **Class Expressions:**
  To deal with simple expressions.

➢ Main Data Structures:

Map to store object code of all operations and directives.
Vector to store modification records.

➢ Algorithms Description:



➢ Assumptions:

1. If an error was found in pass 1, assembler would not start pass 2.
2. The program code with lines ended with object code and object code file are supposed to be displayed in two different text files at the end of pass 2.
3. All output files are saved in pass relative to the running program.

➢ Sample Runs:

Sample 1:

- Input:

q2.txt - Notepad

File Edit Format View Help

```
.234567890123456789012345678
.
          START   0000
BGN       LDA     BETA
          MUL     #4
          RMO     A,S
          LDA     GAMMA
          MUL     #3
          ADDR    S,A
          STA     ALPHA
          J       *
.
ALPHA     RESW    1
BETA      WORD    56
GAMMA     WORD    10
          END     BGN
```

- Output:

Pass2.txt - Notepad

File Edit Format View Help

```
000000              start   0000
000000      BGN     LDA     BETA            032016
000003              MUL     #4              210004
000006              RMO     A,S             ac04
000008              LDA     GAMMA           032011
00000b              MUL     #3              210003
00000e              ADDR    S,A             9040
000010              STA     ALPHA           0f2003
000013              J       *               3f0016
000016      ALPHA   RESW    1
000019      BETA    WORD    56              000038
00001c      GAMMA   WORD    10              00000a
00001f              END     BGN


Assembler Report:

Successfully Assembeled
```

ObjectFile.txt - Notepad

File Edit Format View Help

```
H^        ^000000^1f
T^000000^1c^032016^210004^ac04^032011^210003^9040^0f2003^3f0016^000038^00000a
E^000000
```

Sample 2:

- Input:

trial.txt - Notepad

File Edit Format View Help

```
COPY            START           0
FIRST           STL             2*3
                LDB             #2+3
                BASE            LENGTH
CLOOP           +JSUB           RDREC-5
                LDA             RDREC-LENGTH
                COMP            #0
                JEQ             ENDFIL
                +JSUB           WRREC
                J               CLOOP
.comment
ENDFIL  LDA             EOF
                STA             BUFFER
                LDA             #3
                STA             LENGTH
                +JSUB           WRREC
                J               @RETADR
EOF             BYTE            C'EOS'
RETADR  RESW            1
LENGTH  RESW            1
BUFFER  RESB            4096
RDREC           CLEAR           X
                CLEAR           A
                CLEAR           S
                +LDT            #4096
RLOOP           TD              INPUT
                JEQ             RLOOP
                RD              INPUT
                COMPR           A,S
                JEQ             EXIT
                STCH            BUFFER,X
                TIXR            T
                JLT             RLOOP
EXIT            STX             LENGTH
                lda             #5
INPUT           BYTE            X'F1'
WRREC           CLEAR           X
                LDT             LEN
WLOOP           TD              OUTPUT
                JEQ             WLOOP
                LDCH            BUFFER,X
                WD              OUTPUT
                TIXR            T

                JLT             WLOOP
                lda             #5
OUTPUT  BYTE            X'05'
                END             FIRST
```

- Output:

Pass2.txt - Notepad

File Edit Format View Help

```
000000      COPY     start   0
000000      FIRST    STL     2*3             172003
000003               LDB     #2+3            692fff
000006      CLOOP    +JSUB   RDREC-5         4b101031
00000a               LDA     RDREC-LENGTH    034fd0
00000d               COMP    #0              290000
000010               JEQ     ENDFIL          332007
000013               +JSUB   WRREC           4b10105d
000017               J       CLOOP           3f2fec
00001a      ENDFIL   LDA     EOF             032010
00001d               STA     BUFFER          0f2016
000020               LDA     #3              010003
000023               STA     LENGTH          0f200d
000026               +JSUB   WRREC           4b10105d
00002a               J       @RETADR         3e2003
00002d      EOF      BYTE    C'EOS'          454f53
000030      RETADR   RESW    1
000033      LENGTH   RESW    1
000036      BUFFER   RESB    4096
001036      RDREC    CLEAR   X               b410
001038               CLEAR   A               b400
00103a               CLEAR   S               b440
00103c               +LDT    #4096           75101000
001040      RLOOP    TD      INPUT           e32019
001043               JEQ     RLOOP           332ffa
001046               RD      INPUT           db2013
001049               COMPR   A,S             a004
00104b               JEQ     EXIT            332008
00104e               STCH    BUFFER,X        57c003
001051               TIXR    T               b850
001053               JLT     RLOOP           3b2fea
001056      EXIT     STX     LENGTH          134000
001059               lda     #5              010005
00105c      INPUT    BYTE    X'F1'           F1
00105d      WRREC    CLEAR   X               b410
00105f               LDT     LEN
this symbol isn't define in pass1
001062      WLOOP    TD      OUTPUT          e32011
001065               JEQ     WLOOP           332ffa
001068               LDCH    BUFFER,X        53c003
00106b               WD      OUTPUT          df2008
00106e               TIXR    T               b850
001070               JLT     WLOOP           3b2fef
```

```
00106e              TIXR    T               b850
001070              JLT     WLOOP           3b2fef
001073              lda     #5              010005
001076      OUTPUT  BYTE    X'05'           05
001077              END     FIRST


Assembler Report:

00105f              LDT     LEN
this symbol isn't define in pass1
```

ObjectFile.txt - Notepad

File Edit Format View Help

```
H^       ^000000^1077
T^000000^1a^172003^692fff^4b101031^034fd0^290000^332007^4b10105d^3f2fec^032010
T^000020^1a^0f2016^010003^0f200d^4b10105d^3e2003^454f53^b410^b400^b440^75101000
T^001043^1b^e32019^332ffa^db2013^a004^332008^57c003^b850^3b2fea^134000^010005^F1
T^00105f^17^b410^e32011^332ffa^53c003^df2008^b850^3b2fef^010005^05
M^000006^05
M^000013^05
M^000009^05
M^000019^05
E^000000
```