Experiment No. 05

Aim- Design an implementation of pass II of 2 pass assembler

Requirement- Java and printout pages

Theory-

1. Generate object code by converting symbolic op-code into respective numeric op-code
2. Generate data for literals and look for values of symbols
3. Assemble instructions (generate opcode and look up addresses)
4. Generate data values defined by BYTE, WORD
5. Perform processing of assembler directives not done in Pass 1
6. Write the object program and the assembly listing

Algorithm-

```
begin
 read first input line (from intermediate file)
 if OPCODE ='START' then
 begin
  write listing line
  read next input line
 end {if START}
```

```
write Header record to object program
initialize first Text record
while OPCODE != 'END' do
begin
  if this is not a comment line then
begin
    search OPTAB for OPCODE
    if found then
     begin
      if there is a symbol in OPERAND field then
       begin
        search SYMTAB for OPERAND
        if found then
     store symbol value as operand address
        else
          begin
          store 0 as operand address
          set error flag (undefined symbol)
        end
        end {if symbol}
```

```
        else
         store 0 as operand address
        assemble the object code instruction
 end {if opcode found}
    else if OPCODE ='BYTE' or 'WORD' then
      convert constant to object code
 if object code will not fit into the current Text record then
     begin
      write Text record to object program
      initialize new Text record
     end
 add object code to Text record
    end {if not comment}
 write listing line
 read next input line
 end(while not END)
 write last Text record to object program
 write End record to object program
 write last listing line
end{Pass 2}
```

Code-

```
import java.io.*;
import java.util.*;

class pass2
{
    static int lc=0,sti=0,di=0,i,j,li=0,ri=0,r,lci=0,mci=0,fin=-1,index=0,base=0,ln=0;
    static int[][] symtab = new int[100][3];
    static int[][] littab = new int[100][3];
    static int[][] reg = new int[50][2];
    static String[] sym = new String[100];
    static String[] data = new String[100];
    static String[][] macode = new String[100][4];

    public static int getbr(int n)
    {
        int min=100,pos=-1;
        for(i=0;i<50;i++)
        {
            if(min>Math.abs(reg[i][0]-n) && reg[i][1]==1)
            {
                min=Math.abs(reg[i][0]-n);
                pos = i;
                //System.out.println(min+" "+pos);
            }
        }
        return pos+1;
    }

    public static int getsymlc(String s)
    {
        for(i=0;i<sti;i++)
        {
            if(s.equals(sym[i]))
            {
                return symtab[i][0];
            }
        }
        return -1;
    }

    public static int getlitlc(String s)
    {
        for(i=0;i<di;i++)
        {
            if(s.equals(data[i]))
            {
                return littab[i][0];
```

```
            }
        }
        return -1;
    }

    public static void assmc(String a, String b, String c, String d)
    {
        macode[mci][0] = a;
        macode[mci][1] = b;
        macode[mci][2] = c;
        macode[mci][3] = d;
        //System.out.println(macode[mci][0]+" "+macode[mci][1]+" "+macode[mci][2]);
        mci++;
    }

    public static void main(String []args)
    {
        BufferedReader reader;

        for(i=0;i<50;i++)
        {
            for(j=0;j<2;j++)
            {
                reg[i][j] = 0;
            }
        }

        try
        {
            reader = new BufferedReader(new FileReader("symboltable.txt"));
            String line = reader.readLine();
            while(line!=null)
            {
                String[] words = line.split("\\s+");
                sym[sti] = words[0];
                symtab[sti][0] = Integer.parseInt(words[1]);
                symtab[sti][1] = Integer.parseInt(words[2]);
                symtab[sti][2] = Integer.parseInt(words[3]);
                sti++;
                line = reader.readLine();
            }
            //for(i=0;i<sti;i++) System.out.println(sym[i]+" "+symtab[i][0]+" "+symtab[i][1]+"
"+symtab[i][2]);

            reader = new BufferedReader(new FileReader("literaltable.txt"));
            line = reader.readLine();
            while(line!=null)
            {
                String[] words = line.split("\\s+");
                data[di] = words[0];
```

```
            littab[di][0] = Integer.parseInt(words[1]);
            littab[di][1] = Integer.parseInt(words[2]);
            littab[di][2] = Integer.parseInt(words[3]);
            di++;
            line = reader.readLine();
        }
        //for(i=0;i<di;i++) System.out.println(data[i]+" "+littab[i][0]+" "+littab[i][1]+"
"+littab[i][2]);
        //System.out.println(getlitlc("=F'4'"));
    }
    catch (IOException e) { e.printStackTrace(); }
    // 1 - Base 2 - Index
    try
    {
        reader = new BufferedReader(new FileReader("prg.txt"));
        String line = reader.readLine();
        String[] words = line.split("\\s+");
        ln++;
        //System.out.println(sym[0]+" "+symtab[0][0]);
        while (!words[1].equals("END"))
        {
            if(words[1].equals("USING"))
            {
                String[] opr = words[2].split(",");
                if(opr[0].equals("*"))
                {
                    r = Integer.parseInt(opr[1]);
                    reg[r-1][0] = lc;
                    reg[r-1][1] = 1;
                    //System.out.println(r+" "+reg[r-1][0]+" "+reg[r-1][1]);
                }
                else if(opr[1].matches("[0-9]+"))
                {
                    r = Integer.parseInt(opr[1]);
                    reg[r-1][0] = getsymlc(opr[0]);
                    reg[r-1][1] = 1;
                    //System.out.println(r+" "+reg[r-1][0]+" "+reg[r-1][1]);
                }
                else
                {
                    r = getsymlc(opr[1]);
                    reg[r-1][0] = getsymlc(opr[0]);
                    reg[r-1][1] = 1;
                    //System.out.println(r+" "+reg[r-1][0]+" "+reg[r-1][1]);
                }
            }
            else if(words[1].equals("LA"))
            {
                String[] opr = words[2].split(",");
                r = Integer.parseInt(opr[0]);
```

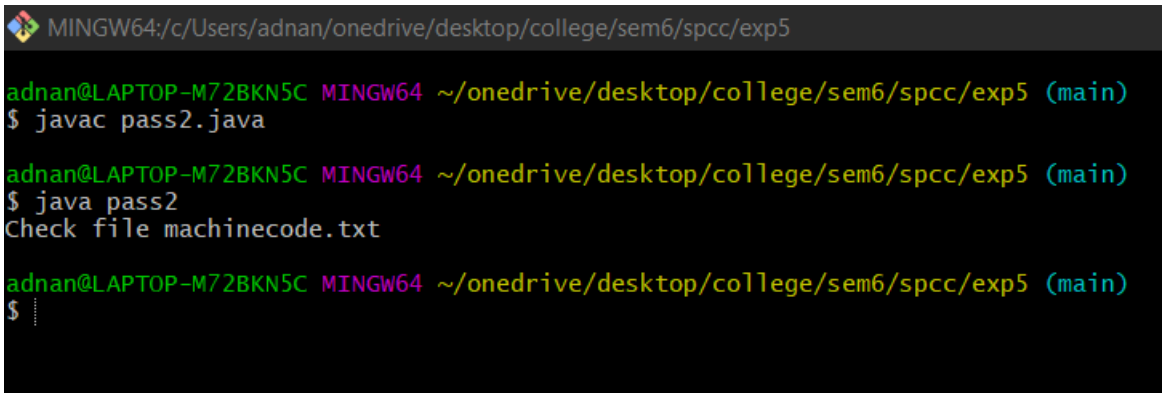
```
                lci = Math.abs(getsymlc(opr[1])-reg[r-1][0]);
                if(fin==-1) index=0;
                assmc(Integer.toString(ln),Integer.toString(lc),words[1],opr[0]+","+Integer.toStri
ng(lci)+"("+Integer.toString(index)+","+Integer.toString(getbr(lci))+")");
                lc+=4;
            }
            else if(words[1].length()>1 && words[1].charAt(1) == 'R' &&
(words[1].equals("SR") || words[1].equals("AR") ||words[1].equals("LR")))
            {
                String[] opr = words[2].split(",");
                if(opr[0].matches("[0-9]+"))
assmc(Integer.toString(ln),Integer.toString(lc),words[1],opr[0]+","+Integer.toString(getsymlc
(opr[1])));
                else if(opr[1].matches("[0-9]+"))
assmc(Integer.toString(ln),Integer.toString(lc),words[1],Integer.toString(getsymlc(opr[0]))+",
"+opr[1]);
                else
assmc(Integer.toString(ln),Integer.toString(lc),words[1],Integer.toString(getsymlc(opr[0]))+",
"+Integer.toString(getsymlc(opr[1])));
                lc+=2;
                if(opr[1].equals("INDEX")) index=getsymlc(opr[0]);
            }
            else if(words[1].equals("L") || words[1].equals("ST") )
            {
                String[] opr = words[2].split(",");
                if(opr[1].charAt(0) == '=')
                {
                    r = getsymlc(opr[0]);
                    lci = Math.abs(getlitlc(opr[1])-6);
                    assmc(Integer.toString(ln),Integer.toString(lc),words[1],Integer.toString(r)+","
+Integer.toString(lci)+"("+Integer.toString(index)+","+Integer.toString(getbr(r))+")");
                }
                else
                {
                    String[] opr21 = opr[1].split("\\(");
                    String op21 = opr21[0];
                    //System.out.println(getsymlc(op21));
                    opr21 = opr21[1].split("\\)");
                    String op22 = opr21[0];
                    //System.out.println(op22);
                    if(op22.equals("INDEX") && op21.equals("DATA1"))
assmc(Integer.toString(ln),Integer.toString(lc),words[1],Integer.toString(getsymlc(opr[0]))+",
0("+Integer.toString(index)+","+Integer.toString(getbr(getsymlc(op21)))+")");
                    else
assmc(Integer.toString(ln),Integer.toString(lc),words[1],Integer.toString(getsymlc(opr[0]))+",
"+Integer.toString(getsymlc(op21)-
6)+"("+Integer.toString(index)+","+Integer.toString(getbr(getsymlc(op21)))+")");
                }
                lc+=4;
            }
```

```
            else if(words[1].equals("A") || words[1].equals("C"))
            {
                String[] opr = words[2].split(",");
                lci = getlitlc(opr[1]);
                assmc(Integer.toString(ln),Integer.toString(lc),words[1],Integer.toString(getsyml
c(opr[0]))+","+Integer.toString(lci-6)+"(0,"+Integer.toString(getbr(lci-6))+")");
                lc+=4;
            }
            else if(words[1].equals("BNE"))
            {
                lci = getsymlc(words[2]) - reg[getbr(7)-1][0];
                assmc(Integer.toString(ln),Integer.toString(lc),"BC","7,"+Integer.toString(lci)+"(
0,"+Integer.toString(getbr(7))+")");
                lc+=4;
            }
            else if(words[1].equals("BR"))
            {
                assmc(Integer.toString(ln),Integer.toString(lc),"BCR",Integer.toString(getbr(Inte
ger.parseInt(words[2])))+","+words[2]);
                lc+=4;
            }
            else if(words[1].equals("LTORG"))
            {
                //System.out.println(di);
                i=1;
                //System.out.println(data[i]);
                String[] opr21 = data[0].split("\\(");
                String op21 = opr21[0];
                //System.out.println(getsymlc(opr21[1]));
                opr21 = opr21[1].split("\\)");
                String op22 = opr21[0];
                assmc(Integer.toString(ln),Integer.toString(littab[0][0]),Integer.toString(getsyml
c(op22)),"");
                //System.out.println("in");
                opr21 = data[1].split("\\'");
                //System.out.println(opr21[0]);
                assmc(Integer.toString(ln),Integer.toString(littab[1][0]),opr21[1],"");
                opr21 = data[2].split("\\'");
                assmc(Integer.toString(ln),Integer.toString(littab[2][0]),opr21[1],"");
                opr21 = data[3].split("\\'");
                assmc(Integer.toString(ln),Integer.toString(littab[3][0]),opr21[1],"");
            }
            else if(words[1].equals("DS"))
            {
                assmc(Integer.toString(ln),Integer.toString(getsymlc(words[0])),"",".");
            }
            else if(words[1].equals("DC"))
            {
                String[] opr21 = words[2].split("\\'");
```

```
                assmc(Integer.toString(ln),Integer.toString(getsymlc(words[0])),"",opr21[1]);
            }
            line = reader.readLine();
            words = line.split("\\s+");
            ln++;
        }
        reader.close();
    }
    catch (IOException e) { e.printStackTrace(); }
    try(OutputStream fw = new FileOutputStream("machinecode.txt"))
        {
            String content = "LN LC Instruction/datum"+System.getProperty("line.separator");
            fw.write(content.getBytes(),0,content.length());
            for(i=0;i<mci;i++)
            {
                //BufferedWriter bw = new BufferedWriter(fw);
                content = macode[i][0]+"    "+macode[i][1]+"    "+macode[i][2]+"
"+macode[i][3]+System.getProperty("line.separator");
                //System.out.println(content);
                fw.write(content.getBytes(),0,content.length());
                //System.out.println(data[i]+" "+littab[i][0]+" "+littab[i][1]+" "+littab[i][2]);
            }
        }
        catch (IOException e) { e.printStackTrace(); }
        System.out.println("Check file machinecode.txt");
    }
}
```

Output-

Execution:



Input File:

prg - Notepad

File Edit View

```
PRGAM2 START 0
         USING *,15
         LA    15,SETUP
         SR    TOTAL,TOTAL
AC       EQU   2
INDEX  EQU   3
TOTAL  EQU   4
DATABASE EQU 13
SETUP  EQU   *
         USING SETUP,15
         L     DATABASE,=A(DATA1)
         USING DATAAREA,DATABASE
         SR    INDEX,INDEX
LOOP   L     AC,DATA1(INDEX)
         AR    TOTAL,AC
         A     AC,=F'6'
         ST    AC,SAVE(INDEX)
         A     INDEX,=F'4'
         C     INDEX,=F'8000'
         BNE   LOOP
         LR    1,TOTAL
         BR    14
         LTORG
SAVE   DS    2000F
DATAAREA EQU *
DATA1  DC    F'01'
       END
```

Machine Code:

machinecode - Note...

File Edit View

```
LN LC Instruction/datum
3     0      LA 15,6(0,15)
4     4      SR 4,4
11    6      L 13,42(0,15)
13    10     SR 3,3
14    12     L 2,0(3,13)
15    16     AR 4,2
16    18     A 2,46(0,15)
17    22     ST 2,58(3,15)
18    26     A 3,50(0,15)
19    30     C 3,54(0,15)
20    34     BC 7,6(0,15)
21    38     LR 1,4
22    40     BCR 15,14
23    48     8064
23    52     6
23    56     4
23    60     8000
24    64      .
26    8064    01
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

<u>Conclusion:</u> Thus we have Implemented program for pass 2 of two pass Assembler.