CMR
INSTITUTE OF
TECHNOLOGY

USN

Internal Assessment Test 1 Answer Key– Sep. 2020										
Sub:	System Software					Sub Code:	18MCA34	Branch:	MCA	
Date:	07/09/2020	Duration:	90 min's	Max Marks:	50	Sem	III			

Q1) Describe SIC/XE Machine Architecture.

1) Memory

- □ Memory consists of 8-bit bytes.
- □ 3 consecutive bytes form a word (24 bits).
- □ All the address in SIC/XE are byte addresses.
- □ Words are addressed by the location of their lowest numbered byte.
- □ Maximum memory available on a SIC/XE system is 1 megabyte (220 bytes).
- □ This increase leads to a change in instruction formats and addressing modes

2) Registers

Five registers of SIC machine remains same in SIC/XE. The additional registers provided by SIC/XE are as follows.

Mnemonic	Number	Use
B	3	Base register; used for addressing.
S	4	General working register – no special use.
T	5	General working register – no special use.
F	6	Floating-point accumulator (48 bits).

3) Instruction Formats

- SIC/XE has larger memory hence instruction format of standard SIC version is no longer suitable.
- SIC/XE provide two possible options; using relative addressing (Format 3) and extend the address field to 20 bit (Format 4).
- In addition SIC/XE provides some instructions that do not reference memory at all. (Format 1 and Format 2) .
- The new set of instruction format is as follows. Flag bit e is used to distinguish between format 3 and format 4. (e=0 means format 3, e=1 means format 4)

1. Format 1 (1 byte)

8

op

Example RSUB (return to subroutine)

opcode
0100 1100
4 C

2. Format 2 (2 bytes)

8	4	4
op	r1	r2

Example COMPR A, S (Compare the contents of register A & S)

Opcode	A	S
1010 0000	0000	0100
A 0	0	4

3. Format 3 (3 bytes)

6	1	1	1	1	1	1	12
op	n	i	x	b	p	e	disp

Example LDA #3(Load 3 to Accumlator A)

0000 00	0	1	0	0	0	0	0000 0000 0011
0	n	i	x	b	p	e	0 0 3

4. Format 4 (4 bytes)

6	1	1	1	1	1	1	20
op	n	i	x	b	p	e	address

Example JSUB RDREC(Jump to the address, 1036)

0100 10	1	1	0	0	0	1	0000 0001 0000 0011 0110

n i x b p e

4) Addressing Modes

Two new relative addressing modes are available for use with instructions assembled using Format 3

Mode	**Indication**	**arget address alculation**
Base Relative	b=1, p=0	TA = (B) + disp (0≤ disp ≤ 4095)
Program-counter relative	b=0, p=1	TA = (PC)+disp (-2048 ≤ disp ≤ 2047)

b represents for base relative addressing where as p represents program counter relative addressing. If both the bits b and p are 0 then target address is taken form the address field of the instruction (i.e displacement)

SIC/XE also support addressing modes that are assembled using Format 4.

Mode	**Indication**	**Target address calculation**
Direct	b=0, p=0, x=0	TA = disp
Indexed	x=1	TA = (x)+disp
Immediate	i=1, n=0	TA = operand value
Indirect	i=0, n=1	TA = address of operand value
simple	i=1, n=1 i=0, n=0	TA = location of the operand value

6) Instruction Set

- SIC/XE provides all of the instructions that are available on the standard version.
- In addition we have, Instructions to load and store the new registers LDB, STB, etc,
- Floating-point arithmetic operations, ADDF, SUBF, MULF, DIVF,
- Register move instruction : RMO,
- Register-to-register arithmetic operations, ADDR, SUBR, MULR, DIVR and,
- Supervisor call instruction : SVC

7) Input and Output

- There are I/O channels that can be used to perform input and output while the CPU is executing other instructions.
- Allows overlap of computing and I/O, resulting in more efficient system operation.
- The instructions SIO, TIO, and HIO are used to start, test and halt the operation of I/O channels.

Q2 a) Define system software? List and explain any four assembler directives with examples.

System Software consists of a variety of programs that support the operation of a computer. It makes possible for the user to focus on an application or other problem to be solved, without needing to know the details of how the machine works internally.
They are usually related to the architecture of the machine on which they are to run.
Example: Assembler, Compiler, text editor, loader and linkers etc.

Assembler Directives
In addition to the mnemonic machine instructions assembler uses following
assembler directives. These statements are not translated into machine instructions.
Instead they provide instructions to assembler itself.
1) START
START specify the name and starting address of the program.
Example: START 1000
2) END
Indicate the end of the source program and (optionally) specify the first
executable instruction in the program.
Example: END FIRST
3) BYTE

Generate character or hexadecimal constant, occupying as many bytes as
needed to represent the constant.
Example: BYTE X’F1’
4) WORD
Generate one-word integer constant
Example: THREE WORD 3
5) RESB
Reserve the indicate number of bytes for a data area.
Example: BUFFER RESB 4096
6) RESW
Reserve the indicate number of words for a data area.
Example: LENGTH RESW 1

Q2 b) Write general description of pass 1 and pass 2 for two pass assembler

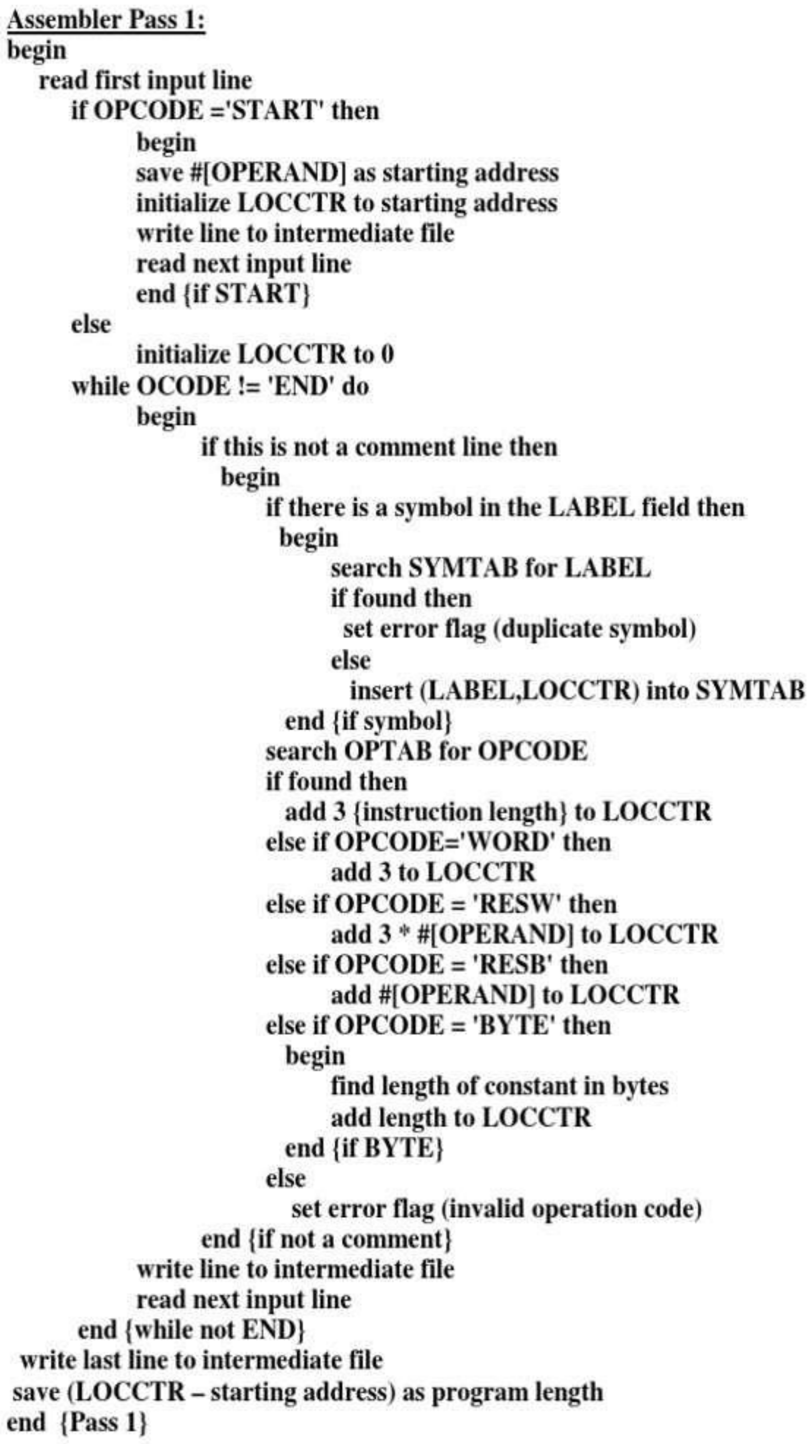
Pass 1 (define symbols)

- Assign addresses to all statements in the program
- Save the addresses assigned to all labels for use in Pass 2
- Perform some processing of assembler directives, (including those for address assignment, such as BYTE and RESW

Pass 2 (assemble instructions and generate object program)

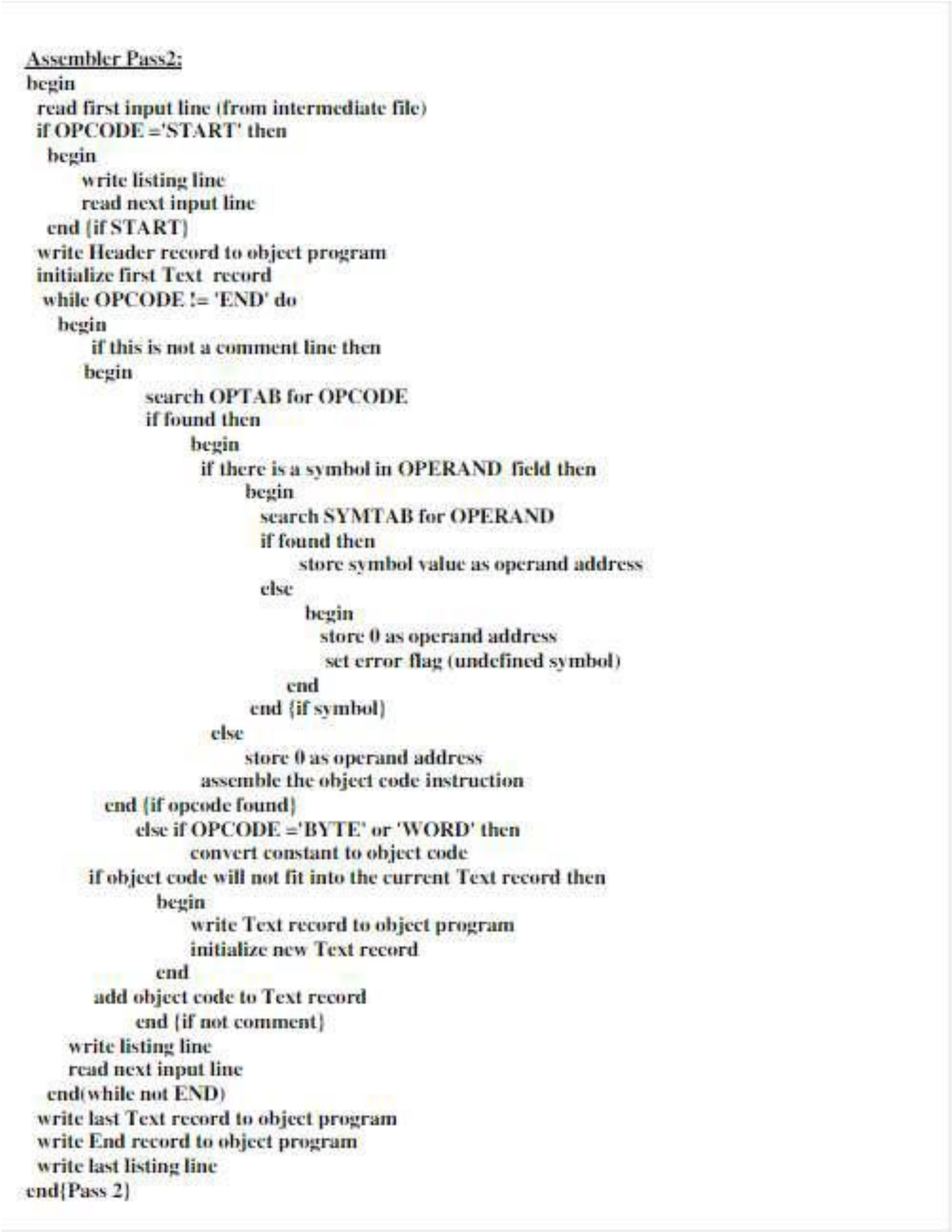
- Assemble instructions (translate opcodes and look up addresses)
- Generate data values defined by BYTE, WORD etc.
- Perform processing of assembler directives not done during Pass 1
- Write the object program and the assembly listing

Q3) Write pass 1 Algorithm for pass two assembler



```
Assembler Pass 1:
begin
    read first input line
        if OPCODE ='START' then
                begin
                save #[OPERAND] as starting address
                initialize LOCCTR to starting address
                write line to intermediate file
                read next input line
                end {if START}
        else
                initialize LOCCTR to 0
        while OCODE != 'END' do
                begin
                        if this is not a comment line then
                          begin
                                if there is a symbol in the LABEL field then
                                  begin
                                        search SYMTAB for LABEL
                                        if found then
                                          set error flag (duplicate symbol)
                                        else
                                          insert (LABEL,LOCCTR) into SYMTAB
                                  end {if symbol}
                                search OPTAB for OPCODE
                                if found then
                                  add 3 {instruction length} to LOCCTR
                                else if OPCODE='WORD' then
                                        add 3 to LOCCTR
                                else if OPCODE = 'RESW' then
                                        add 3 * #[OPERAND] to LOCCTR
                                else if OPCODE = 'RESB' then
                                        add #[OPERAND] to LOCCTR
                                else if OPCODE = 'BYTE' then
                                  begin
                                        find length of constant in bytes
                                        add length to LOCCTR
                                  end {if BYTE}
                                else
                                  set error flag (invalid operation code)
                        end {if not a comment}
                write line to intermediate file
                read next input line
         end {while not END}
  write last line to intermediate file
 save (LOCCTR – starting address) as program length
end  {Pass 1}
```

Q4) Write pass 2 Algorithm for pass two assembler



```
Assembler Pass2:
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}
```

Q5 a) Write a program for SIC and SIC/XE machine to perform ALPHA = 11+BETA * 4

```
LDA         BETA
```

```
                MUL         FOUR
                ADD         ELEVEN
                STA         ALPHA
ELEVEN          WORD        11
FOUR            WORD        4
BETA            RESW        1
ALPHA           RESW        1
```

```
                LDA         #4
                MUL         BETA
                ADD         #11
                STA         ALPHA
BETA            RESW        1
ALPHA           RESW        1
```

Q6 a) Give the target address generated for following machine instruction.

if (B)=006000 (PC)=003000 (x)=000090 i)75101000 ii)032026 iii)03C300 iv)0310C303

i)75101000

000110	1	0	0	0	1	0	0000 0000 0000

TA= operand value

TA = 01000

ii) 032026

000000	1	1	0	0	1	0	0000 0010 0110

TA= disp+(PC)

TA= 026+003000

TA=3026

iii) 03C300

000000	1	1	1	1	0	0	0011 0000 0000

TA=disp + (x) + (b)
TA= 6390

iv) 0310C303

000000	1	1	0	0	0	1	0000 1100 0011 0000 0011

TA= C303

Q7 a) List and describe data structures used by two-pass assembler

1) OPTAB:

- It is used to lookup mnemonic operation codes and translates them to their machine language equivalents.
- In more complex assemblers the table also contains information about instruction format and length
- In pass 1 the OPTAB is used to look up and validate the operation code in the source program.
- In pass 2, it is used to translate the operation codes to machine language.
- In simple SIC machine this process can be performed in either in pass 1 or in pass 2.
- But for machine like SIC/XE that has instructions of different lengths, we must search OPTAB in the first pass to find the instruction length for incrementing LOCCTR.
- In pass 2 we take the information from OPTAB to tell us which instruction format to use in assembling the instruction, and any peculiarities of the object code instruction.
- OPTAB is usually organized as a hash table, with mnemonic operation code as the key.
- The hash table organization is particularly appropriate, since it provides fast retrieval with a minimum of searching.
- Most of the cases the OPTAB is a static table- that is, entries are not normally added to or deleted from it. In such cases it is possible to design a special hashing function or other data structure to give optimum performance for the particular set of keys being stored.

2) **SYMTAB:**

- This table includes the name and value for each label in the source program, together with flags to indicate the error conditions (e.g., if a symbol is defined in two different places).
- During Pass 1: labels are entered into the symbol table along with their assigned address value as they are encountered. All the symbols address value should get resolved at the pass 1.
- During Pass 2: Symbols used as operands are looked up the symbol table to obtain the address value to be inserted in the assembled instructions.
- SYMTAB is usually organized as a hash table for efficiency of insertion and retrieval. Since entries are rarely deleted, efficiency of deletion is the important criteria for optimization.

3) **LOCCTR:**

 Apart from the SYMTAB and OPTAB, this is another important
variable which helps in the assignment of the addresses.
 LOCCTR is initialized to the beginning address mentioned in the
START statement of the program.
 After each statement is processed, the length of the assembled
instruction is added to the LOCCTR to make it point to the next
instruction.
 Whenever a label is encountered in an instruction the LOCCTR value
gives the address to be associated with that label.

Q10 a) Write object program format. (Header, Text, End Record) for the following code

	QUIZ	START	**0**	
0000	FIRST	LDA	FIVE	000015
0003		STA	ALPHA	0C001B
0006		LDA	TWO	000018
0009		STA	BETA	0C001E
000C		LDA	ALPHA	00001B
000F		ADD	BETA	18001E
0012		STA	RESULT	0C0021
0015	FIVE	WORD	5	
0018	TWO	WORD	2	
001B	ALPHA	RESW	1	
001E	BETA	RESW	1	
0021	RESULT	RESW	1	
		END	FIRST	

HQUIZ 000000000023
T00000120000150C001B0000180C001E0C0021
E000000