## Chapter 5

## Combinational Logic with MSI and LSI

***1.*** Specify the advantages of MSI devices over the SSI gates. Using MSI circuits, construct a binary parallel adder to add two 16-bit binary numbers----------**14**

## Chapter 7

## Registers,Counters and The Memory Unit

***2.*** Explain the importance of the access time of a memory unit.draw the block diagram of a memory unit that communicates with multiple registers in memory transfer microprogram----------**13**,**14**

***3.*** A microprocessor uses RAM chips of 1024*1 capacity----------**12**

a. How many chips are needed and how should their address lines be connected to provide a memory capacity of 1024 bytes

b. How many chips are needed to provide a memory capacity of 16K bytes? Explain in words how the chips are to be connected to the address bus

***4.*** What is binary cell? Explain how a group of binary binary cell work together as a memory unit with proper sketches----------**13**,**14**

***5.*** How a memory unit communicates with external registers? Explain memory transfer operation with necessary diagram----------**12**

***6.*** What are the functions of MAR and MBR? Show the information transfer in an integrated circuit memory during a read operation? ----------**11**

***7.*** Why Direct Memory Access(DMA) is used in computer? Show the block diagram of a DMA controller----------**15**

## Chapter 8

## Register Transfer Logic

***8.*** What is register-transfer logic method? Why this method is used in digital system design?--**15**

***9.*** How the basic operations of a digital system can be represented by the register transfer logic? ----------**12**

***10.*** What is register-transfer logic method? Explain how a group of four components that form the basis of the register transfer logic method for designing digital systems----------**14**

***11.*** Show the hardware implementation of the following register-transfer statements:----------**15**

a. $A_4x : A \leftarrow A + 1$

   $A_4 \ : A \leftarrow 0$

b. $T_1 \ : R_2 \leftarrow R_1$

   $T_2 \ : R_2 \leftarrow R_2$

   $T_3 \ : R_3 \leftarrow 0$

c. $T_4 \ : A \leftarrow A + B$

   $T_6 \ : A \leftarrow A + 1$

***12.*** Show the hardware implementation of the following register-transfer statements:----------**14**

a. $T_1 \ : R_2 \leftarrow R_1$

   $T_2 \ : R_2 \leftarrow \overline{R_2}$

   $T_3 \ : R_2 \leftarrow 0$

b. $xT_2 \ : F \leftarrow 1$

   $\overline{x}T_2 \ : F \leftarrow 0$

c. $x + yz' : A \leftarrow A + B$

$y + xz : A \leftarrow A - 1$

**13.** Show the hardware implementation of the following register-transfer statements: -------**11,13**

a. $T_1 : R_2 \leftarrow R_1$

$T_2 : R_2 \leftarrow \overline{R_2}$

b. $xT_0 + T_1 : A + B$

$\overline{x}T_1 : A + 1$

c. $P : A \vee B$

$\overline{P} : A \leftarrow 0$

**14.** The following register transfer operations specify a four state control of the sequence register and decoder type. G is a 2-bit sequence register and $T_0, T_1, T_2, T_3$ are the outputs of the decoder.----------**14**

$xT_0 : G \leftarrow G + 1$

$yT_0 : G \leftarrow 10$

$zT_0 : G \leftarrow 11$

$T_1 + T_2 + T_3 : G \leftarrow G + 1$

a. Draw the state diagram of the control

b. Design the sequence register with JK flip-flops

**15.** What is modular approach? Why this approach is used in designing digital system -------**11,13**

**16.** How can we describe the operation of a digital system? What are most commonly used microoperations?----------**11**

**17.** What is bus system? ----------**11**

**18.** Briefly explain the concept of data bus and address bus. Design a bus system for four registers ----------**11,15**

**19.** What do you mean by overflow? How an overflow is detected in sign magnitude representation of data?----------**15**

## Chapter 9
## Processor Logic Design

**20.** What is scratchpad memory? Draw the block diagram of processor units with one-port and two-port scratchpad memory----------**14**

**21.** Why scratchpad memory is used in processors? Distinguish between single-port and 2-port scratchpad memory----------**15**

**22.** How scratchpad memory improves the performance of a processor unit? Draw and explain the block diagram of a processor unit with 2-port scratchpad memory----------**12,14**

**23.** A processor unit has 64 registers of 8-bit each. We want to replace the registers by a scratchpad memory of one-port:----------**14(Problem 9-4)**

a. What would be the size of the scratchpad memory

b. How many lines are needed for address?

c. How many lines are there for input data?

**24.** What are the factors that should consider by a designer in designing a processor unit ---**11,13**

**25.** An ALU can be defined by the following Boolean functions:----------**15**

$X_i = A_i B_i + (S_2 S_1' S_0')' A_i + S_2 S_1 S_0' B_i$

$Y_i = S_0 B_i + S_1 B_i' (S_2 S_1 S_0')'$

$Z_i = S_2' C_i$

One typical stage of this ALU is built by an FA shown in above fig. Determine the 12 factors in ALU

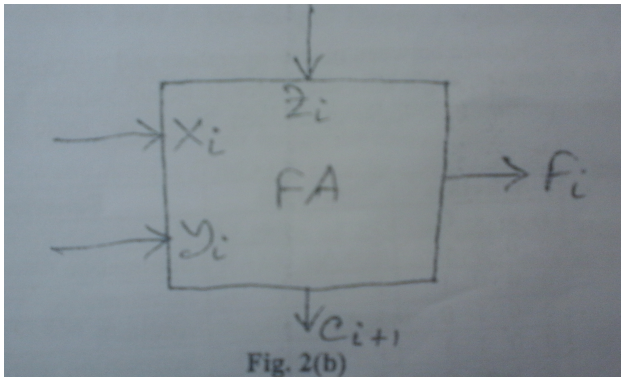
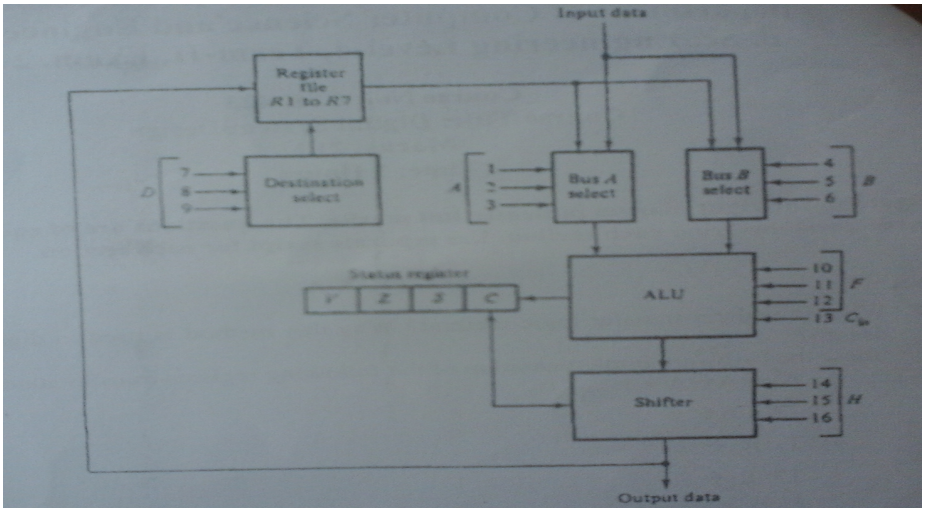


Fig. 2(b)

***26.*** Specify the 16 bit control word that must be applied to the processor of the below fig. To implement the following micro-operations----------**15**

a. $R_2 \leftarrow R_1 + 1$
b. $R_6 \leftarrow \overline{R_6}$
c. $R_2 \leftarrow clc\ 2$
d. $R_3 \leftarrow R_4 \oplus R_5$




***27.*** Draw the block diagram of a 4-bit processor unit with its 16 control variables. Also specify the control word that must be applied to implement the following microoperations ---------**14**

a. $R_2 \leftarrow R_1 + 1$
b. $R_6 \leftarrow \overline{R_6}$
c. $R_2 \leftarrow shl\ R_1$

***28.*** Draw the block diagram of a processor unit with its control word. Specify the control word that must be applied to the processor to implement the following micro-operations: --------**12**

a. $R_3 \leftarrow R_4 + R_5$
b. $R_7 \leftarrow R_7 - 1$
c. $R_1 \leftarrow shr\ R_1$
d. $R_3 \leftarrow R_1 \oplus R_2$

e. $R_6 \leftarrow R_7$

**29.** Implement the following operations with hardware:----------**12**

a. $W \quad : M[A] \leftarrow B$

b. $x + \overline{y} : A \leftarrow A + B$

$x + y : A \leftarrow A + 1$

c. $A_4' x \quad : A \leftarrow A + 1$

$A_4' \quad : A \leftarrow 0$

d. $xT_3 \quad : A \leftarrow B, B \leftarrow A$

e. $x + y : A \vee B$

**30.** Describe the steps involved in the design of an ALU----------**15**

**31.** What is status register?describe its advantages and disadvantages ---------- **11,12,13,15**

**32.** How can you compare two numbers by using the status bits of a processor----------**12**

**33.** Discuss the commonly used status bits and their design principle----------**15**

**34.** Design a combinational logic shifter that can perform transfer, shift-right, shift-left and clear operations----------**12**

**35.** Design a 4-bit combinational logic shifter? Why are need to design such combinational shifter? ----------**11,15**

**36.** Why combinational logic shifter is used in processors instead of shift register----------**11,12,13**

**37.** Design one stage of an accumulator register that can perform the following operations -----**12**

a. $P_1 : A \leftarrow \overline{A}$

b. $P_2 : A \leftarrow A + 1$

c. $P_3 : A \leftarrow A + B$

d. $P_4 : A \leftarrow A - B$

e. $P_5 : A \leftarrow A - 1$

f. $P_6 : A \leftarrow A \wedge B$

g. $P_7 : A \leftarrow \overline{A \wedge B}$

**38.** Write down some advantages of using an accumulator register. Design one typical stage of an accumulator that can perform the following micro-operations----------**15**

a. $P_1 : A \leftarrow A + B$

b. $P_2 : A \leftarrow A - B$

c. $P_3 : A \leftarrow A - 1$

d. $P_4 : A \leftarrow shl\ A$

e. $P_5 : A \leftarrow A \vee B$

f. $P_6 : A \leftarrow A \oplus B$

**39.** Using JK flip-flops design one stage of an accumulator register that performs the following operations:----------**11**

a. $P_1 : A \leftarrow A + B$

b. $P_2 : A \leftarrow A - B$

c. $P_3 : A \leftarrow \overline{A \vee B}$

d. $P_4 : A \leftarrow \overline{A \wedge B}$

e. $P_5 : A \leftarrow shr\ A$

f. $P_6 : A \leftarrow A + 1$

***40.*** Using JK flip-flop, design one typical stage of an accumulator that performs the following operations: ----------**13,14**

| Control variable | Microoperation |
|---|---|
| $P_1$ | $A \leftarrow A + B$ |
| $P_2$ | $A \leftarrow 0$ |
| $P_3$ | $A \leftarrow \overline{A}$ |
| $P_4$ | $A \leftarrow A \wedge B$ |
| $P_5$ | $A \leftarrow A \vee B$ |
| $P_6$ | $A \leftarrow A \oplus B$ |
| $P_7$ | $A \leftarrow A \odot B$ |

***41.*** Design an arithmetic circuit that increment and decrement a sign magnitude number using two selection variables. Also design the control unit----------**15**

***42.*** What is the difference between macro-operation and micro-operation----------**15**

***43.*** Design an arithmetic logic unit with three selection variables $s_2, s_1, s_0$ that generates the following arithmetic logic operations. Draw the logic diagram of one typical stage: ----------**15**

| **Selection** $s_2$ | $s_1$ | $s_0$ | $C_{in}$ | **Output** | **Function** |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | $F = A - B$ | Subtraction |
| 0 | 0 | 0 | 1 | $F = A + 1$ | Increment A |
| 0 | 0 | 1 | 0 | $F = A + B$ | Addition |
| 0 | 0 | 1 | 1 | $F = A - B - 1$ | Subtraction with borrow |
| 0 | 1 | 0 | 0 | $F = A + B + 1$ | Add with carry |
| 0 | 1 | 0 | 1 | $F = A$ | Transfer A |
| 0 | 1 | 1 | 0 | $F = A - 1$ | Decrement A |
| 0 | 1 | 1 | 1 | $F = A$ | Transfer A |
| 1 | 0 | 0 | X | $F = \overline{A}$ | Complement A |
| 1 | 0 | 1 | X | $F = A \wedge B$ | AND |
| 1 | 1 | 0 | X | $F = A \vee B$ | OR |
| 1 | 1 | 1 | X | $F = A \oplus B$ | X-OR |

***44.*** Design an arithmetic circuit with two selection variables $s_1 and\ s_0$ that generates the following arithmetic operations. Also draw the logic diagram of a typical one stage:----------**12**

| $s_1$ $s_0$ | $C_{in}=0$ | $C_{in}=1$ |
|---|---|---|
| 0 0 | $F=A+B$ | $F=A+B+1$ |
| 0 1 | $F=A+\overline{B}$ | $F=A+\overline{B}+1$ |
| 1 0 | $F=A-B-1$ | $F=A-B$ |
| 1 1 | $F=A$ | $F=A+1$ |

***45.*** Design an arithmetic circuit with two selection variables $s_1 and\ s_0$ that generates the following arithmetic operations.draw the logic diagram of one typical stage:----------**11,13**

| $s_1$ $s_0$ | $C_{in}=0$ | $C_{in}=1$ |
|---|---|---|
| 0 0 | $F=A+B$ | $F=A+B+1$ |
| 0 1 | $F=A$ | $F=A+1$ |
| 1 0 | $F=B-A-1$ | $F=B-A$ |
| 1 1 | $F=A-B-1$ | $F=A-B$ |

***46.*** Design an arithmetic circuit with two variables $s_1 and\ s_0$ that generates the following arithmetic operations of the table:----------**14**

| $s_1$ $s_0$ | $C_{in}=0$ | $C_{in}=1$ |
|---|---|---|
| 0 0 | $F=A$ | $F=A+1$ |
| 0 1 | $F=A+B$ | $F=A+B+1$ |
| 1 0 | $F=A+B'$ | $F=A+B'+1$ |
| 1 1 | $F=A-1$ | $F=A$ |

Also modify the designed arithmetic circuit into an ALU with a mode selection variable $s_2$. when $s_2=0$ the ALU performs the arithmetic operations of above table and when $s_2=1$ the ALU performs the logic functions according to below table

| $s_2$ $s_1$ $s_0$ | $C_{in}=0$ |
|---|---|
| 1 0 0 | $F=A \wedge B$ |

| | | | |
|---|---|---|---|
| 1 | 0 | 1 | $F = A \oplus B$ |
| 1 | 1 | 0 | $F = A \vee B$ |
| 1 | 1 | 1 | $F = A'$ |

***47.*** A 4-bit ALU is enclosed within one IC package. Show the connections among three such IC's to form a 12-bit ALU. designate the input and output carries in the 12-bit ALU----------**13**

## Chapter 10
## Control Logic Design

***48.*** Distinguish between hardware control and microprogram control----------**11,13**

***49.*** Distinguish between hardware control and software control----------**12**

***50.*** Write down the basic steps of a hardware control design? ----------**12**

***51.*** Explain the importance of control logic design in digital system----------**11,14**

***52.*** Show interaction between the control unit and the data processor----------**11,15**

***53.*** What is the difference between hard-wared control and micro-program control? ---------**11,15**

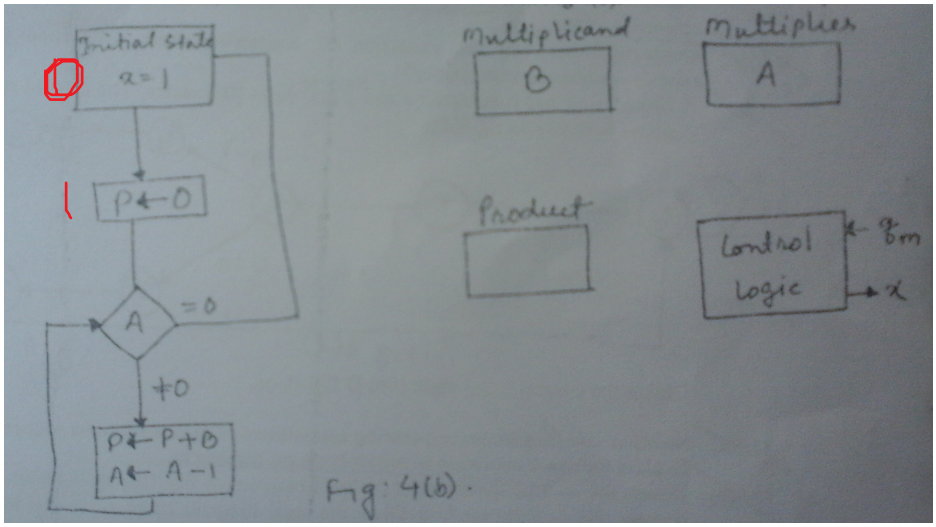
***54.*** Design a digital system with complete control logic that can perform addition and subtraction of binary fixed point numbers where negative numbers are in sign-2's complement form. Use one flip-flop per stage method for control logic design.----------**11**

***55.*** Mention the several address sequencing capabilities of a microprogram sequencer.
----------**12,14**

***56.*** Why microprogram sequencer is used? Draw the block diagram of a typical microprogram sequencer and explain its operation and application.----------**11,13**

***57.*** Design an arithmetic circuit that multiplies two fixed point binary number in sign magnitude representation. Use hardware control method for designing the control
----------**14**

***58.*** The register configuration and flowchart of a digital system that multiplies two unsigned binary numbers by repeated addition method is shown in below fig.----------**12**




a. What will be the size of register P if both A and B are 4 bit registers?
b. Draw the state diagram for control and list the register transfers to be executed in each control state

c. Draw the block diagram of the data processing part
d. Design the control by one flipflop per state method

***59.*** Draw the block diagram of a microprogram control for processor unit. Also write a program for this microprogram control that compares two unsigned binary numbers stored in R1 and R2. the register containing the smallest number is then cleared. If two numbers are equal then both the registers are cleared----------**14**

***60.*** Design the microprogram control for processor unit. Write down the microprogram for counting the numbers of 1's presently stored in R1 register of the processor. Also, show the flow chart of the problem----------**12**

***61.*** Design a digital system that adds and subtracts two binary fixed point numbers representation in sign 2's complement form.use only hardwired control to design control logic----------**13**

***62.*** A digital system that adds and subtracts two binary fixed point numbers representation in sign 2's complement form. The addition of two numbers stored in registers of finite length may result in a sum that exceeds the storage capacity of the register by one bit. The extra bit is called overflow----------**12**

a. Give the equipment configuration for the adder-subtractor circuits
b. Draw the flow charts of the sign-magnitude addition and subtraction
c. Draw the state diagram and list of micro-operations
d. Construct a control logic using one flip-flop per state method

***63.*** For the circuit shown in below **fig**.----------**14**

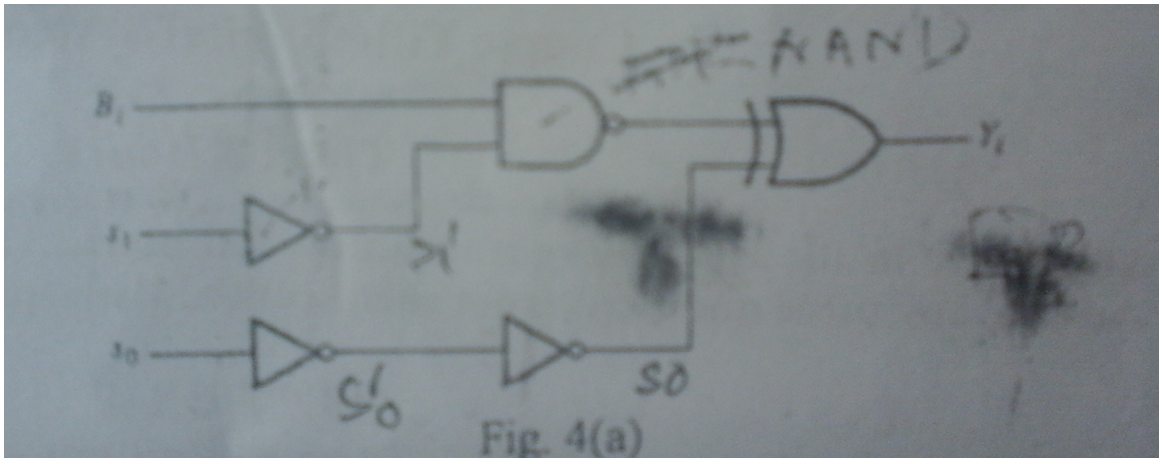


Fig. 4(a)

a. Derive the Boolean function for output $Y_i$ as a function of $B_i, s_1, s_0$
b. Draw the truth table
c. Draw the function table and determine the operations performed by the circuit

***64.*** Design a digital system that multiplies two fixed point binary numbers (unsigned) by the repeated addition method. Use microprogram control----------**11,13**

***65.*** Design a digital system that multiplies two unsigned binary numbers by the repeated addition. Your answer should include the following ----------**11**

a. State diagram for the control and the register transfer micro-operation, to be executed in each control state
b. Flowchart of the multiplication by successive addition
c. The block diagram of data processor part
d. The control by the sequence register and decoder method

***66.*** Discuss the importance of designing a control unit.----------**12,13,15**

***67.*** Describe how control and data processor interact with each other----------**12**,**13**

***68.*** A control unit has two inputs x and y and five states as shown in below fig. Design a control using

a. PLA control ----------**11**,**13**

b. One flip-flop per state method----------**11**

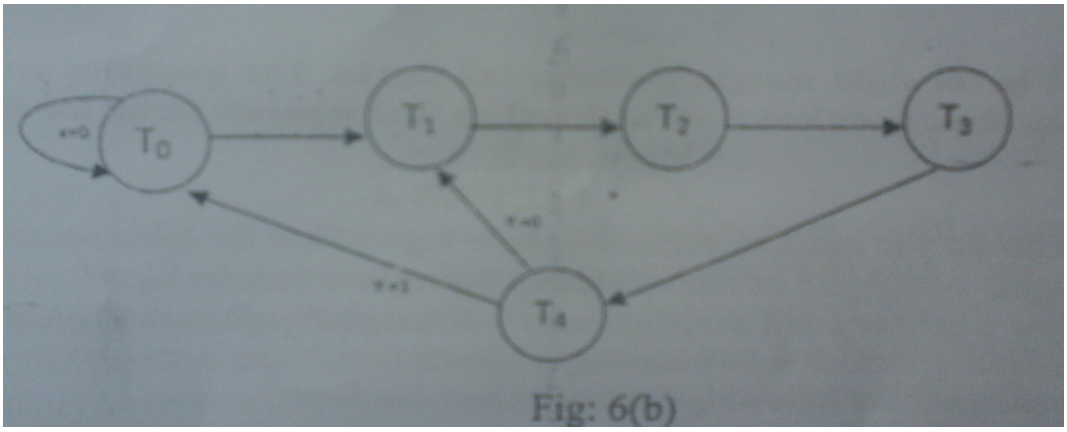


Fig: 6(b)

***69.*** A control unit has 4 states and 2 inputs x and y as below fig. Design the control buy using one flip-flop per state method----------**13**

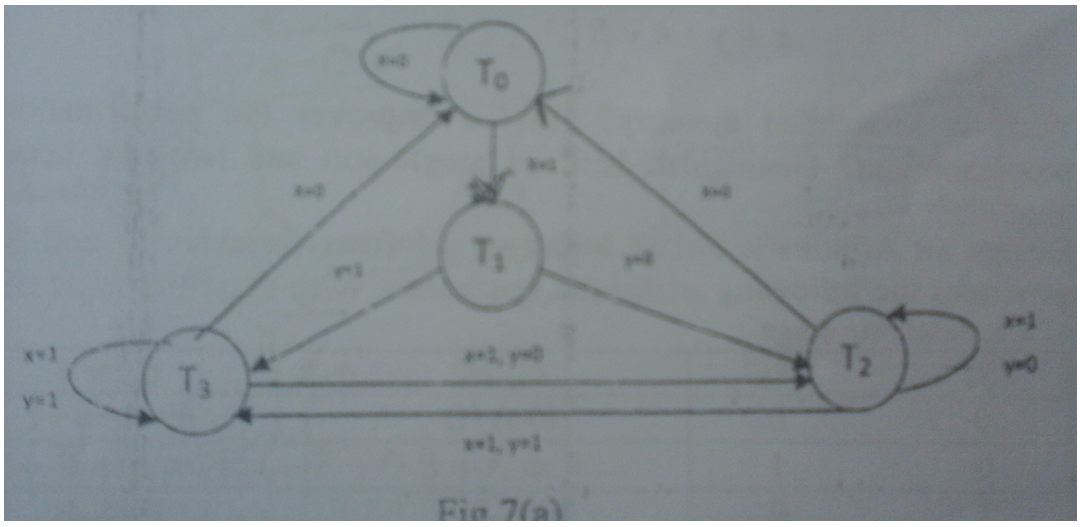


Fig 7(a)

***70.*** A control unit has 8 states and 2 inputs x and y as below fig. Design the control buy using D flip-flop ----------**12**,**13**

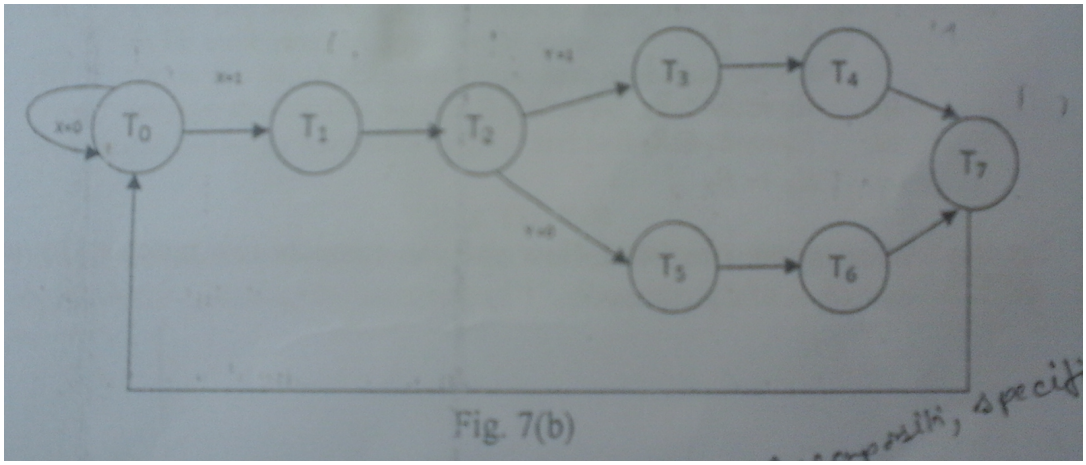
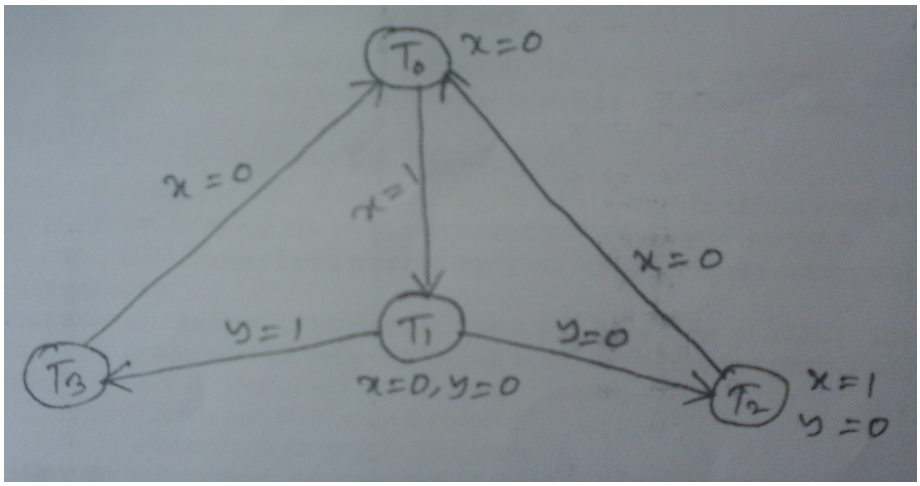


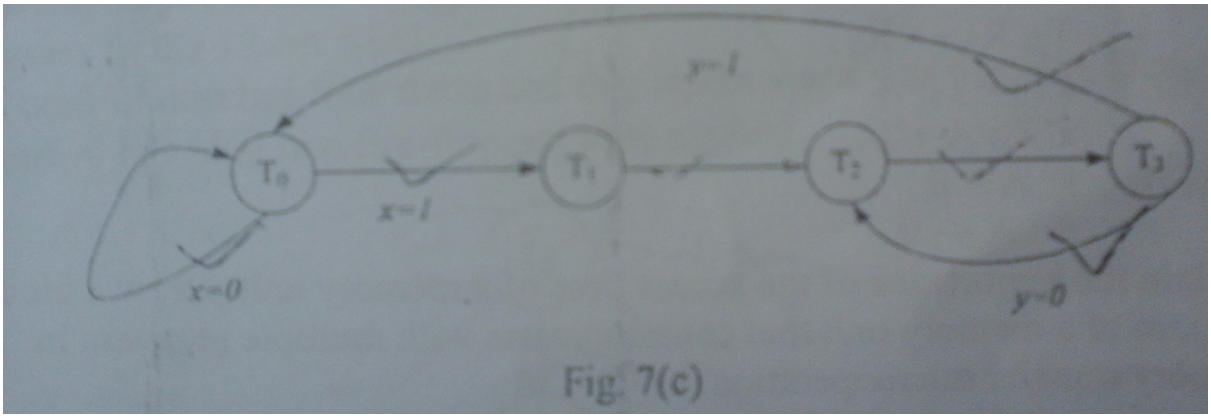
Fig. 7(b)

***71.*** A control unit has four states ( $T_0, T_1, T_2$ *and* $T_3$ ) and two inputs (x and y) as shown in below **fig.** Design the control using one flip-flop per state method----------**15**

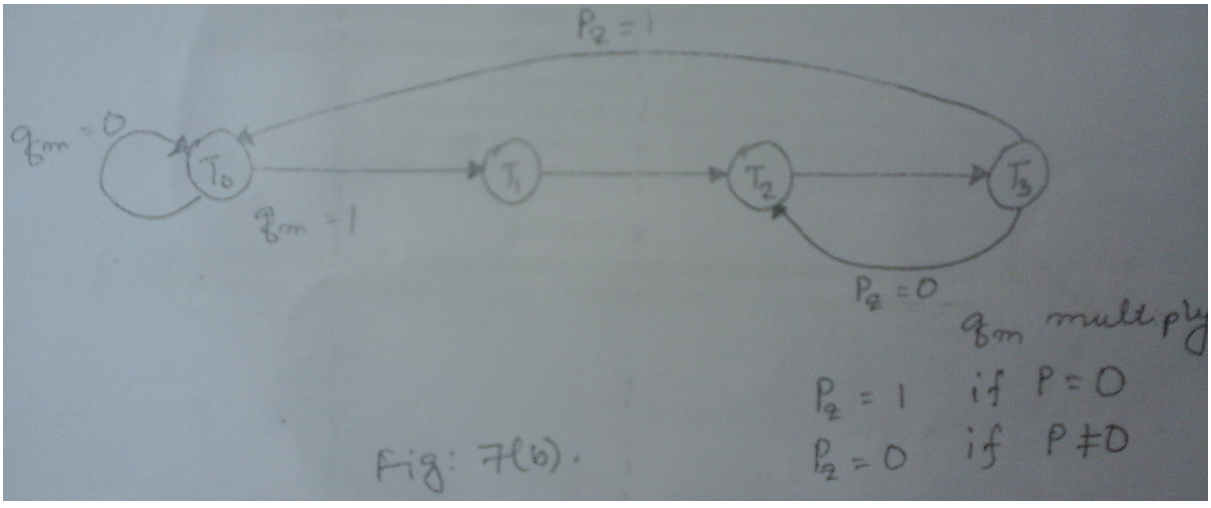



***72.*** A control unit has two inputs x and y and four states. Design the control logic using -----**12**,**14**

a. PLA
b. Sequence register and decoder method with its hardware implementation




***73.*** Design the control specified by the state diagram of the below fig. By the sequence register and decoder method. Draw the logic diagram using gates and D flip-flops----------**12**



## Chapter 11
## Computer Design

***74.*** Explain the several phases for designing a digital computer. Draw the block diagram of a digital computer by specifying its each block with their functions ----------**12,13**

***75.*** State six steps used to design a computer. By following these steps design a simple computer that can perform the following micro-operations:----------**15**

a. AND to A
b. ADD to A
c. Branch unconditionally
d. Clear A
e. Increment A
f. Hash computer
g. Input to A
h. Output from A

***76.*** Design a simple computer that can execute the following instructions(here m is the address part of the instructions)----------**14**

| symbol | Hexadecimal code | function |
|---|---|---|
| AND | 0 m | $A \leftarrow A \wedge B$ |
| ADD | 1 m | $A \leftarrow A + B$ |
| STO | 2m | $M \leftarrow A$ |
| CA | 6800 | $A \leftarrow 0$ |
| CMA | 6801 | $A \leftarrow \overline{A}$ |
| INC | 6802 | $A \leftarrow A + 1$ |
| HLT | 6001 | $S \leftarrow 0$ |

Also give a guideline to design the control unit for this computer

***77.*** Describe how the following instructions can be incorporated in a computer.

a. Store in A----------**11**
b. Increment and skip if zero (ISZ)----------**11,13**
c. Branch unconditionality (BUZ)----------**11,13**
d. Branch to subroutine (BSB)----------**11,13**

***78.*** Design a simple computer that can perform the following instructions:----------**11**

| Operation code | Mnemonic | Description | Function |
|---|---|---|---|
| 00000001 | ADD R | Add R to A | $A \leftarrow A + R$ |
| 00000010 | ADI OPRD | Add operand to A | $A \leftarrow A + OPRD$ |
| 00000011 | ADA ADRS | Add direct to A | $A \leftarrow A + M[ADRS]$ |

## Chapter 12

## Microcomputer System Design

***79.*** A microprocessor employs RAM chips of 256*8 and ROM chips of 1024*8. The system needs 2K bytes of RAM, 4k bytes of ROM and four interface units,each with four registers ------**14**,**15**

a. How many RAM and ROM chips are needed?
b. Draw memory address map for the system
c. Give the address range in hexadecimal for RAM,ROM and interface

***80.*** Explain how a subroutine is called and return from a subroutine with a numerical example. Write a sequence of three instructions to be stored in memory locations 5, 6 and 7. They should check if the output device is empty and if so transfer a character from the accumulator .----------**13**,**15**

***81.*** Explain how a subroutine is called and return from a subroutine according to memory-reference instruction----------**12**

***82.*** Explain how a subroutine is called and return from a subroutine with a numerical example by using stack pointer----------**12**

***83.*** What is tristate buffer? Why tristate buffer is used in system design? Describe bidirectional bus using tristate buffers with necessary diagram----------**14**,**15**

***84.*** Why tri-state buffers are used as bus? Describe unidirectional and bidirectional bus buffers ----------**12**

***85.*** What is the difference between stack pointer and stack register?----------**15**

***86.*** How would you sequence a program that needs two memory stacks maintained throughout the program with a microprocessor that has only one stack pointer ----------**15**

***87.*** Describe the stack operation in micro-program sequencer----------**12**

## Others

***88.*** Explain how a conditional statement is implemented by hardware with proper example ----**13**

***89.*** Distinguish between the execution of register-reference instruction and memory-reference instruction----------**12**

***90.*** Classify the microcomputer interface components in commercial use.----------**11,13**

***91.*** What is carry propagation? How it makes a full adder circuit efficient?----------**11,13**

***92.*** Derive the PLA program table for a combinational circuit that squares a 3-bit number. Minimize the power(confused to detect from question) of product terms? ----------**11**

## Mixed

***93.*** Define the following terms:

a. ALU----------**15**
b. Processor----------**15**
c. Microprocessor----------**15**
d. Microcomputer----------**15**

***94.*** Distinguish between:

a. carry and overflow----------**14**
b. Arithmetic shift and logical shift----------**14**
c. Numerical and non-numerical data----------**14**
d. CPU and processor----------**14**
e. Microprocessor and microcomputer----------**12**