Unit-4 Microprogrammed Control

1) Describe the following terms: Microperation, microinstruction, microprogram, microcode.

Microperations:

In computer central processing units, micro-operations (also known as a micro-ops or μops) are detailed low-level instructions used in some designs to implement complex machine instructions (sometimes termed macro-instructions in this context).

Micro instruction:

- A symbolic microprogram can be translated into its binary equivalent by means of an assembler.
- Each line of the assembly language microprogram defines a symbolic microinstruction.
- Each symbolic microinstruction is divided into five fields: label, microoperations, CD, BR, and AD.

Microprogram:

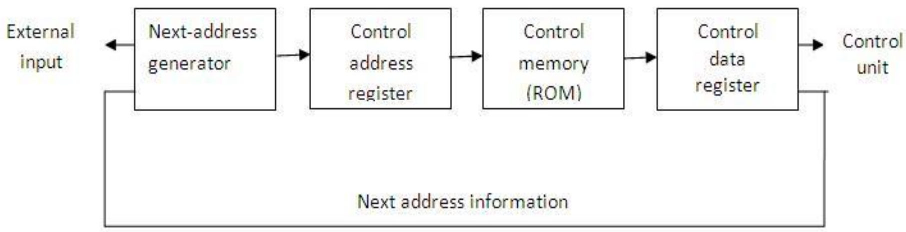
- A sequence of microinstructions constitutes a microprogram.
- Since alterations of the microprogram are not needed once the control unit is in operation, the control memory can be a read-only memory (ROM).
- ROM words are made permanent during the hardware production of the unit.
- The use of a micro program involves placing all control variables in words of ROM for use by the control unit through successive read operations.
- The content of the word in ROM at a given address specifies a microinstruction.

Microcode:

- Microinstructions can be saved by employing subroutines that use common sections of microcode.
- For example, the sequence of micro operations needed to generate the effective address of the operand for an instruction is common to all memory reference instructions.
- This sequence could be a subroutine that is called from within many other routines to execute the effective address computation.

2) Draw and explain the organization of microprogrammed control unit.

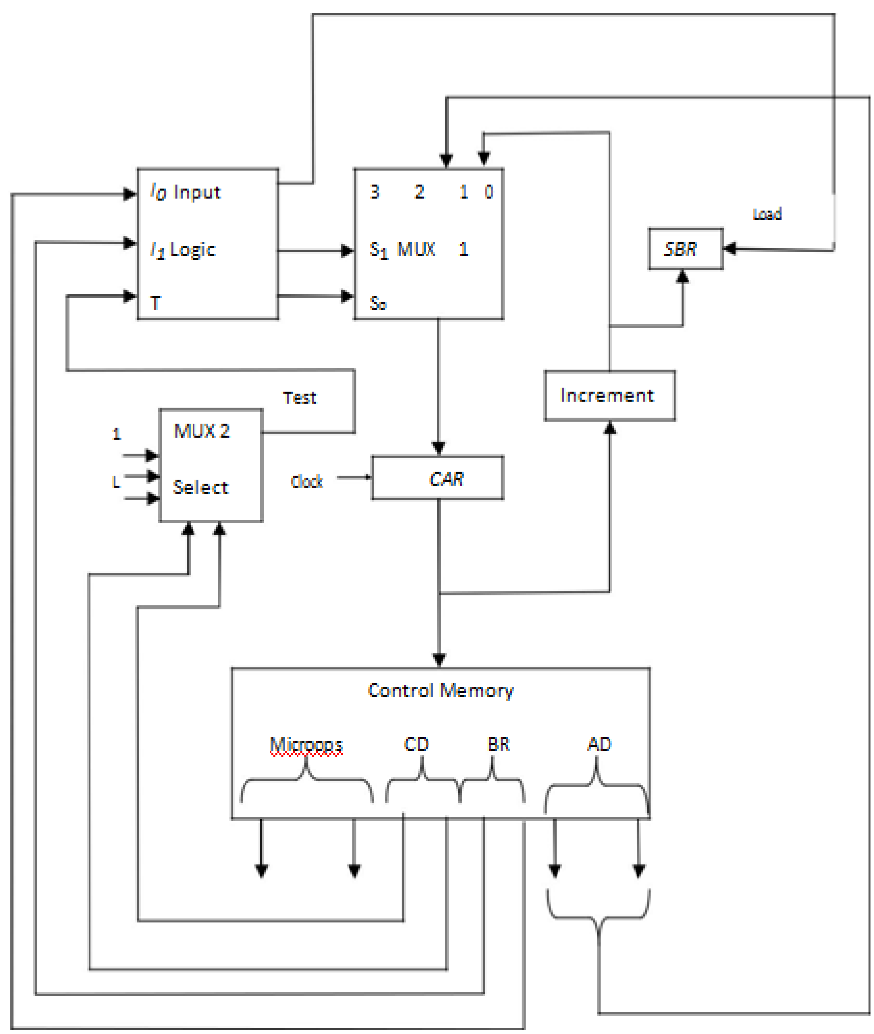
- A sequence of microinstructions constitutes microprogram.
- A control unit whose binary control variables are stored in memory is called a microprogrammed control unit.
- Since alterations of the microprogram are not needed once the control unit is in operation, the control memory can be a read-only memory (ROM).
- The content of the words in ROM are fixed and cannot be altered by simple programming since no writing capability is available in the ROM.



- ROM words are made permanent during the hardware production of the unit.
- The use of a microprogram involves placing all control variables in words of ROM for use by the control unit through successive read operations.
- The content of the word in ROM at a given address specifies a microinstruction.
- A memory that is control memory part of a control unit is referred to as a control memory. A computer that employs a microprogrammed control unit will have two separate memories: a main memory and a control memory.
- The main memory is available to the user for storing the programs.
- The contents of main memory may alter when the data are manipulated and every time that the program is changed.
- The user's program in main memory consists of machine instructions and data.
- In contrast, the control memory holds a fixed microprogram that cannot be altered by the occasional user.
- The microprogram consists of microinstructions that specify various internal control signals for execution of register microoperations.
- Each machine instruction initiates a series of microinstructions in control memory. These microinstructions generate the microoperations to fetch the instruction from main memory; to evaluate the effective address, to execute the operation specified by the instruction, and to return control to the fetch phase in order to repeat the cycle for the next instruction.
- The general configuration of a microprogrammed control unit is demonstrated in above block diagram.
- The control memory is assumed to be a ROM, within which all control information is permanently stored.
- The control memory address register specifies the address of the microinstruction, register and the control data register holds the microinstruction read from memory.
- The microinstruction contains a control word that specifies one or more micro- operations for the data processor.
- Once these operations are executed, the control must determine the next address. The location of the next microinstruction may be the one next in sequence, or it may be located somewhere else in the control memory.
- For this reason it is necessary to use some bits of the present microinstruction to control the generation of the address of the next microinstruction.
- The next address may also be a function of external input conditions.
- While the microoperations are being executed, the next address is computed in the next address generator circuit and then transferred into the control address register to read the next microinstruction.
- Thus a microinstruction contains bits for initiating microoperations in the data processor part and bits that determine the address sequence for the control memory.

3) **Draw the diagram of Micro programmed sequencer for a control memory and explain it. Microprogram sequencer: OR Explain address sequencing using block diagram.**

- The basic components of a microprogrammed control unit are the control memory and the circuits that select the next address.
- The address selection part is called a microprogram sequencer.
- A microprogram sequencer can be constructed with digital functions to suit a particular application.
- To guarantee a wide range of acceptability, an integrated circuit sequencer must provide an internal organization that can be adapted to a wide range of applications.
- The purpose of a microprogram sequencer is to present an address to the control memory so that a microinstruction may be read and executed.
- Commercial sequencers include within the unit an internal register stack used for temporary storage of addresses during microprogram looping and subroutine calls.
- Some sequencers provide an output register which can function as the address register for the control memory.



- The block diagram of the microprogram sequencer is shown in above figure. There are two multiplexers in the circuit.
- The first multiplexer selects an address from one of four sources and routes it into a control address register CAR.
- The second multiplexer tests the value of a selected status bit and the result of the test is applied to an input logic circuit.
- The output from CAR provides the address for the control memory.
- The content of CAR is incremented and applied to one of the multiplexer inputs and to the subroutine registers SBR.
- The other three inputs to multiplexer number 1 come from the address field of the present microinstruction, from the output of SBR, and from an external source that maps the instruction.
- Although the diagram shows a single subroutine register, a typical sequencer will have a register stack about four to eight levels deep. In this way, a number of subroutines can be active at the same time.
- A push and pop operation, in conjunction with a stack pointer, stores and retrieves the return address during the call and return microinstructions.
- The CD (condition) field of the microinstruction selects one of the status bits in the second multiplexer.
- If the bit selected is equal to 1, the T (test) variable is equal to 1; otherwise, it is equal to 0. The T value together with the two bits from the BR (branch) field goes to an input logic circuit.
- The input logic in a particular sequencer will determine the type of operations that are available in the unit.
- Typical sequencer operations are: increment, branch or jump, call and return from subroutine, load an external address, push or pop the stack, and other address sequencing operations.
- With three inputs, the sequencer can provide up to eight address sequencing operations. Some commercial sequencers have three or four inputs in addition to the T input and thus
- provide a wider range of operations.