Unit 3

1. What is an instruction? Explain about the microoperation.

Instruction is a set a set of binary codes that specifies the microoperation that is to be carried out by the computer to perform an action. The instruction itself alone is the opcode and is paired with data from the register or any memory locations.

Microoperation is a fractional part of the actual operation that is to be performed by the computer when instructions are provided to it. A sequence of such microoperation collectively performs an operation in the computer system.   
Say, for the Fetch operation to perform in the computer system, smaller microoperations take place in computer system.

AR 🡨 PC (PCTAR)

IR🡨 M[AR] (memory read), PC 🡨 PC+1 (increment PC)

The concept of microoperation can be perceived with the comparison to machine cycles and instruction cycle, where a completion of multiple machine cycles leads to a complete instruction to perform.

1. What is the instruction format? Explain the direct and indirect addressing with suitable examples.

Instruction format is the way of dividing a n-bit binary code into different parts such that each part reciprocates different meaning to it and has its own unique functionality, which is processed by the system accordingly to get the required results.

In the exemplary system designed by Morris Mano, the instruction (16-bit) can be divided into 3 components.

* B15: used to denote the addressing mode of the instruction
* B14 – B12: Provides the opcode of the instruction
* B11 – B0: Provides the address of the operand for the instruction

Memory addresses of the basic computer is of 12 bits. Ie. From the combination of the 12 bits, we can access up to 4096 new memory locations within the memory of the basic computer.

We know that the first bit of the instruction format dictates the addressing mode of the instruction. Based on the value it contains; we can determine if the instruction is “direct addressing” or “indirect addressing” in nature.

If B15 = 0: Direct addressing

IF B15 = 1: Indirect addressing

In a stored program organization, for directly addressed instructions, the addresses of the operands (effective address) in the same memory are directly passed as a part of the instruction code. However, in Indirectly addressed instructions, the effective addresses of the operands are further addressed by the addresses sent by the instructions.

For example:

Instruction code: 0 001 110011011010

Is a directly addressed instruction, where the last 12 bits provides the addresses for the operand to execute the instruction by the opcode of 001

Similarly, 1 001 110011011010; would be an indirectly addressed instruction which would cross reference to the effective address from the provided address for the instruction to gain the require operand for operation.

1. Explain about the different instruction referencing techniques used while designing the Basic Computer with examples.
2. How does hardwired CU differ from microprogrammed CU?

Difference between hardwired CU and microprogrammed CU.

Hardwired CU:

* Is made using logic gates and sequential circuits
* Is very harsh to bring modifications in, a small change can change entire systems
* Can be optimized to fast mode of operation.

Microprogrammed CU:

* A control memory, which contains microprograms to activate necessary control signals instead of logic gates.
* If logic is changed, smaller modifications can be brought to the microprograms to reflect the differences.
* Is relatively slower than Hardwired CU.

1. What is a system bus? Explain the bus system of the Basic Computer system.

System bus is basically a combined bus system within the CPU, that is used to communicate data and signals to different components of the CPU, such as registers, ALU etc. The signal bus can be utilized by any of the 8 registers of the CPU and the accumulator, which can be monitored by using 3 control signals.

Here to consider is that, the sizes of the registers are not the same whatsoever. While the PC (Program counter) is of 12 bits (for 12-bit addresses) the registers such as data registers are of 16-bit. Therefore, the 16-bit common bus is used to accommodate all sizes of data.   
for ex. With respect to registers such as INTR, and OUTR, only the lower order data that flows in the common bus are sent.

1. Suppose you need to design a computer with a memory size of 64K words, with each word 32-bit in length. An instruction word is one of the words which has; an addressing bit, opcode, register code and an address. Find the no. of bits required for each section of an instruction and show the Instruction format required to design this system. Make assumptions if any.

In the basic computer system designed by Morris Mano, the computer can access up to 4096 words, which consisted of memory addresses of 12-bit length.

In this hypothetical system, consisting of memory size of 64KB and each memory address of 32-bit of length.

In this system, the number of bits required to access the whole 64K of memory is 16 bits. Let B0 to B15 of the instruction code represent the address of the operand in the instruction format.

Similarly, since each word of the memory is 32 bits, the length of the instruction format must be of 32 bit.

For a 32-bit length system, let us assume the size of instruction be of 8 bits.

No of bits required to refer those instruction be of 8 bits (B16 to B24). Which means there are a total of 256 instructions in the hypothetical computer system.   
let us assume that this system consists of 16 registers to work with. Therefore, to identify 16 registers in the system, let us used 4 bits in the instruction format to address the registers (B25 to B28). Additionally, the remaining 3 bits (B28 to B31). among the 32 bits can be used to determine the addressing modes of the instruction.

1. What is instruction set completeness? Explain the different reference instructions of Basic computer design.

Instruction set completeness is the quality of the instruction which proves that a given computer system can perform the following set of actions within the computer system utilizing the available instruction set.

1. Explain the full working flow of the Basic computer with the help of a flow chart.
2. What is an interrupt? Explain the interrupt cycle of Basic Computer with the help of flow chart.