

SOLUTION TO TUTORIAL SHEET 2

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QUESTION 1: Write the micro-operations to evaluate the arithmetic expression. $X = (A + B * C) / (D - E/F)$.

- a. Using a general register computer with three address instruction.**
- b. Using a general register computer with two address instruction.**
- c. Using an accumulator type computer with one address instruction.**
- d. Using stack organized computer with zero address instruction.**

SOLUTION 1:

- a) MUL R1, B, C
ADD R2, R1, A
DIV R1, E, F
SUB R3, D, R1
DIV X, R1, R3

Here, R1, R2, and R3 are processor registers that store intermediate results, and memory location X holds the final result.

- b)
MOV R1, B
MUL R1, C
ADD R1, A
MOV R2, E
DIV R2, F
MOV R3, D
SUB R3, R2
DIV R1, R3

MOV X, R1

Here, R1, R2, and R3 are processor registers that store intermediate results, and memory location X holds the result.

c)

LOAD B
MUL C
ADD A
STORE T
LOAD E
DIV F
STORE U
LOAD D
SUB U
STORE U
LOAD T
DIV U
STORE X

In this instruction, all operations are done between the accumulator and operands from locations in the memory (T, U, X).

d)

PUSH B
PUSH C
MUL
PUSH A
ADD
PUSH D
PUSH E
PUSH F
DIV
SUB
DIV
POP X

All addresses are implicit, and result is popped to memory location X.

QUESTION 2: Discuss one suitable example (real life scenario) where the following addressing mode can be used:

- a. Implied addressing mode.**
- b. Immediate addressing mode.**
- c. Register addressing mode.**
- d. Register indirect addressing mode.**
- e. Direct addressing mode.**
- f. Indirect addressing mode.**
- g. PC Relative addressing mode.**
- h. Indexed addressing mode.**
- i. Auto-Increment addressing mode.**
- j. Auto-Decrement addressing mode.**
- k. Base Address Register addressing mode.**

SOLUTION 2:

- a) In this addressing mode, the definition of the instruction itself specifies the operands implicitly.

Implied addressing modes are used for Zero-address instructions in Stack organized architecture, or One-address instructions in an Accumulator organized architecture. Some examples are Instructions such as CMA (Complement Accumulator) or CLA (Clear Accumulator).

- b) In immediate addressing mode, when the instruction is assembled, the operand comes explicitly and immediately after the opcode.

For instance, instructions like 'ADD 10', which will increment the value stored in the accumulator by 10, use the immediate addressing mode.

- c) Register addressing mode involves the use of registers to hold the data to be manipulated.

This mode is used in instructions such as 'ADD R', which will increment the value stored in the accumulator by the content of register R.

- d) In this addressing mode, the address field of the instruction refers to a CPU register that contains the effective address of the operand, unlike the previous mode which holds the operand itself.

This mode is used in instructions such as 'ADD R', which will increment the value stored in the accumulator by the content of memory location specified in register R.

- e) This mode is used to access static data and can also be used in the implementation of variables.

Example instruction: Add R1, (1001).

- f) This mode is used in the implementation of pointers, since they are essentially memory locations that store the address of another variable.

Further, it is also used when passing arrays as parameters to functions since the array name passed is just a pointer to the base address of the array.

- g) This mode is heavily used in branch type instructions since direct updating of the program counter is often involved.

- h) Index Mode is used to access an array whose elements are in successive memory locations.

The content of the instruction code represents the starting address of the array and the value of the index register, and the index value of the current element. By incrementing or decrementing index register different element of the array can be accessed.

- i) In this mode, after operand addressing, the contents of the register are incremented. Thus, it proves to be particularly useful in implementation of loops, and further traversing through arrays in a loop.

- j) Opposite to Auto-Increment, after operand addressing, the contents of the register are decremented.

This is used for similar applications such as loops, and implementation of push/pop functions of a stack.

- k) Base register addressing mode is used to implement inter segment transfer of control and is very suitable for program relocation during runtime.