# CDA4150 Lecture Notes

01-28-04

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## Topics Covered

- Multiplication of binary integers
- Addressing Modes



## Multiplication of two binary integers

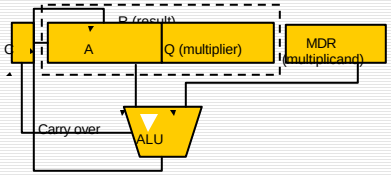
- Consider multiplying two 4 bit integers in a 4 bit machine

```
   1011    multiplicand (MDR)
 X 1101    multiplier (Q)
1000 1111  result (R)
```

Result is 16 bits resulting in overflow condition!

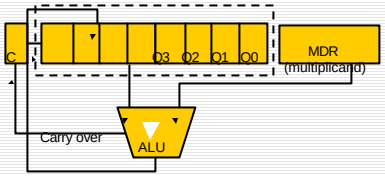


## Design Representation



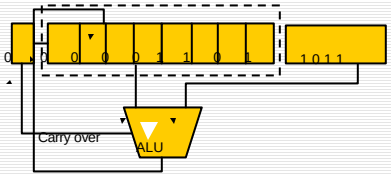



## Multiplication of two binary integers






## Initial Conditions



## Steps to Follow

Initial Step: A = to MDR

1. Test Q0 for 1 or 0

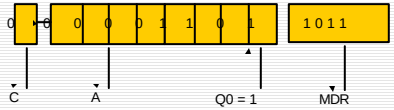
2. a. If Q0 = 1; C, A=A+MDR
   Move bits to right.. *(shift_right C-A-Q)*
   b. If Q0 = 0; *(shift_right C-A-Q)*

3. Do step 1 until all bits in Q are tested



## Step-by-Step

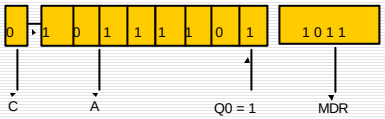
- Fill initial values






## Step-by-Step

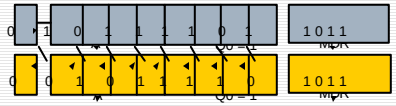
- Set A = MDR






## Step-by-Step

- Q0 = 1
- C = A+MDR

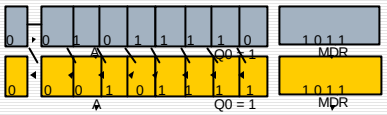



- Shift bits to the right



## Step-by-Step

- Q0 = 0

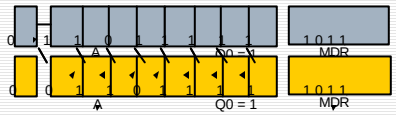



- Shift bits to the right



## Step-by-Step

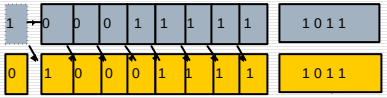
- Q1 = 1
- C = A + MDR




- Shift bits to the right

## Step-by-Step

- Q1 = 1
- C = A + MDR

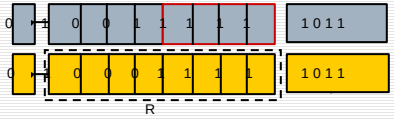



- Shift bits to the right



## Step-by-Step

- All Bits in Q tested
- R = result





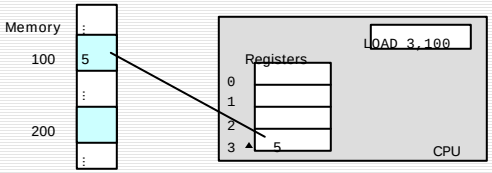

## Addressing Modes

- Direct
- Immediate
- Indirect
- Register Direct
- Register Indirect
- Register Indirect plus Offset



## Direct Addressing

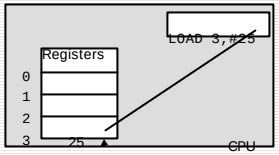
Used for manipulating an absolute address.
Example: LOAD R1, <ADDR>
will load the contents of <ADDR> into R1






## Immediate Addressing

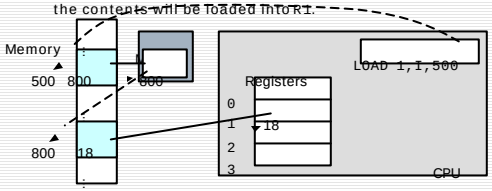
Used when dealing with constants.
Example: LOAD R1, #value
will load value into R1.





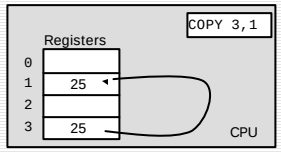

## Indirect Addressing

Typically used for accessing a value through a pointer.
Example: LOAD R1,I,<ADDR>
Contents of <ADDR> stores another address in which the contents will be loaded into R1.



## Register Direct Addressing

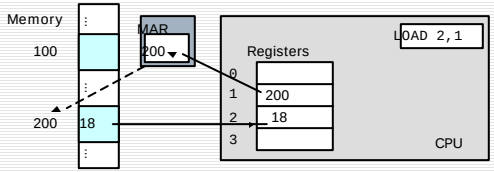
Used to copy the contents of one register into another.
Example: `COPY R2,R1` or `MOVE R2,R1`
will copy contents of `R1` into `R2`.






## Register Indirect Addressing

Typically used for accessing a list of consecutive memory locations.
Example: `LOAD R2,<R1>`
will load the contents of address stored in `R1` into `R2`






## Register Indirect Addressing plus Offset

Typically used when accessing array and structures.
Example: `LOAD R2,R1,offset`
will load the contents of address stored in `R1+offset` into `R2`