Restoring Division

Longhand division in binary is similar to that in decimal

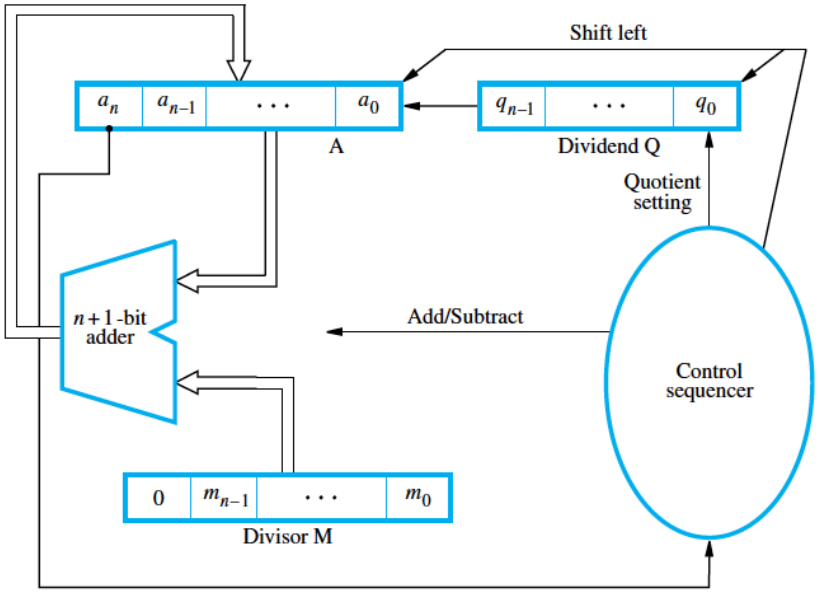
```
        21                    10101
   13 ) 274        1101 ) 100010010
        26                 1101
        --                 ----
         14                 10000
         13                  1101
         --                  -----
          1                    1110
                               1101
                               ----
                                  1
```

Both a quotient and a remainder are produced

Handle signed numbers by dividing the positive equivalents
Sign of remainder = sign of dividend (dividend rule)
Quotient is negative if the divisor and dividend differ in sign

Restoring Division

Set A to 0
Put divisor in M
Put dividend in Q



Repeat the following 3 steps n times:

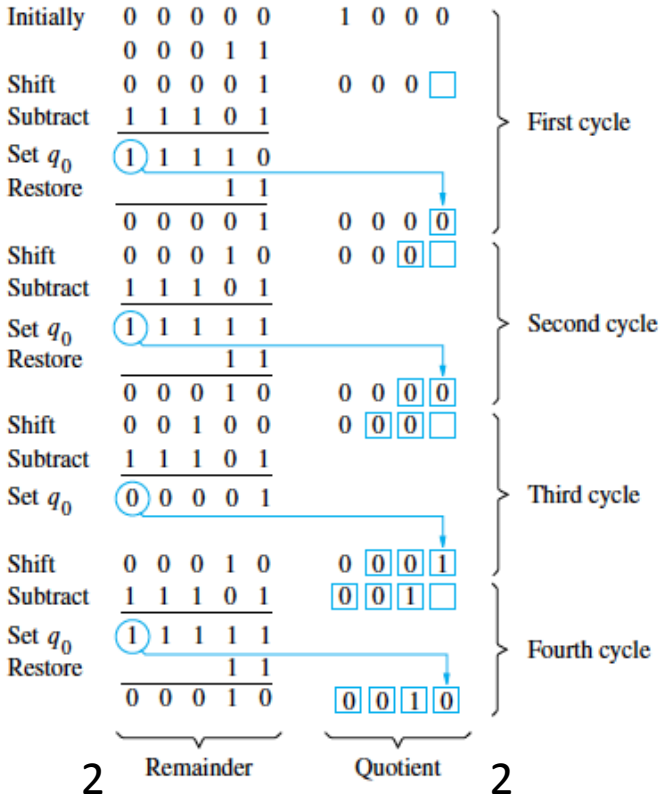
1. Shift A and Q left one bit position
2. Subtract M from A
3. If A is negative, set q_0 to 0 and add M back to A (i.e. restore A); otherwise set q_0 to 1

When done, Q contains quotient and A contains the remainder

Restoring Division Example

Assume 4-bit values. Division of 8 by 3

$$
\begin{array}{r}
10 \\
11\overline{)\,1000} \\
11 \\
\hline
10
\end{array}
$$



Non-Restoring Division

Avoids having to add M back when subtracting makes A<0

Restoring division computes A-M and if negative adds A back before shifting left 1 bit for the next cycle

Shifting A-M left first and then adding M gives:

- 2(A-M)+M = 2A – M (which is needed in the next cycle)
- This avoids the restore step

Non-Restoring Division Algorithm

Stage 1: Repeat the following 2 steps n times:

1. If A<0, shift A and Q left 1 bit and add M to A
   Else shift A and Q left 1 bit and subtract M from A

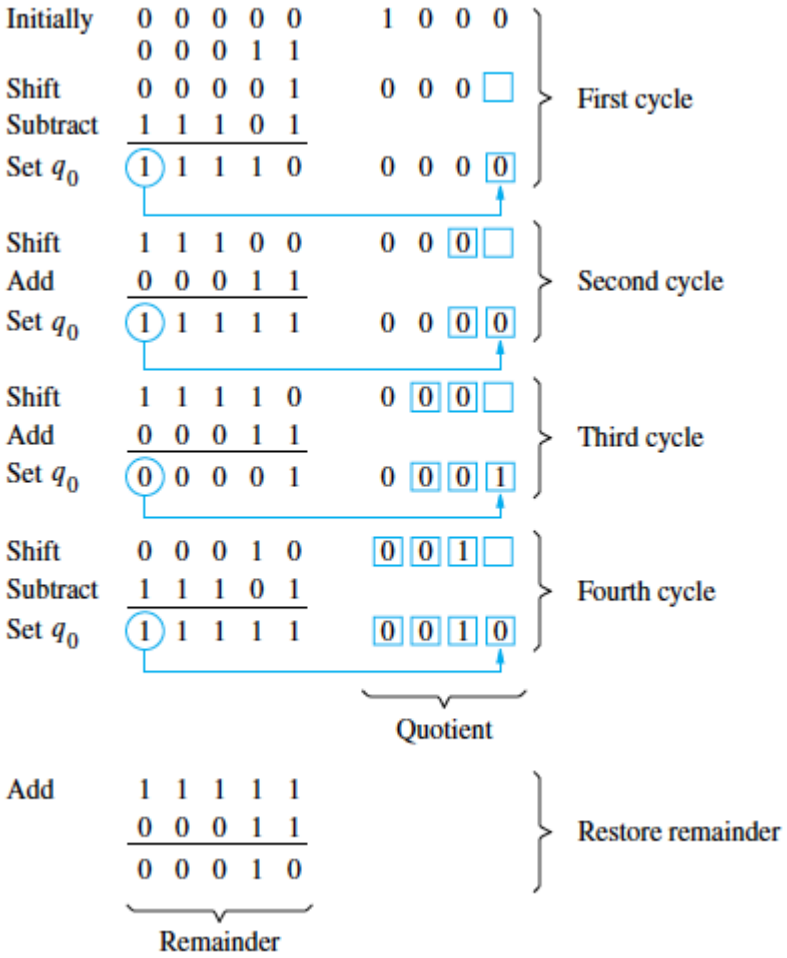
2. If A<0, set $q_0 = 0$ else set $q_0 = 1$

Stage 2: If A<0, add M to A

Stage 2 is needed to leave the proper positive remainder in A

Non-Restoring Division Example

Assume 4-bit values. Division of 8 by 3



Division of Signed Integers

Use absolute values of the dividend and divisor

Quotient is negative if the signs of divisor & dividend differ

Sign of remainder should match the sign of the dividend
this is called the dividend rule