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DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

EXPERIMENT - 2

AIM: To demonstrate the Restoring Division Algorithm for 2 unsigned binary numbers.

Submission Sheet

SAP ID	Name of Student	Date of Experiment	Date of Submission	Remarks
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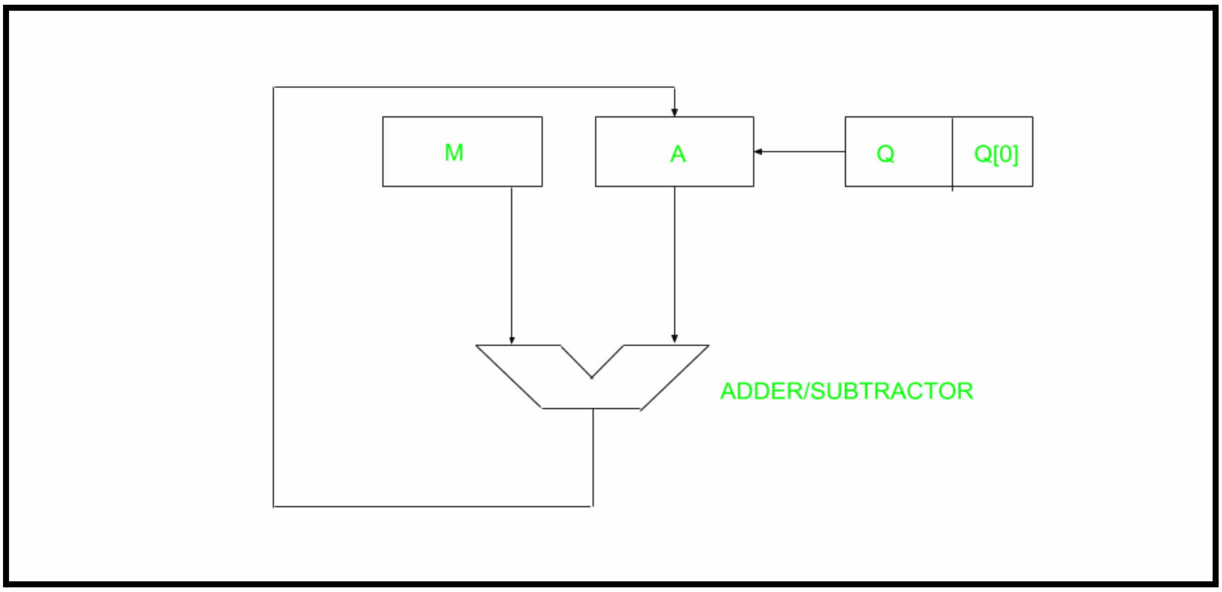
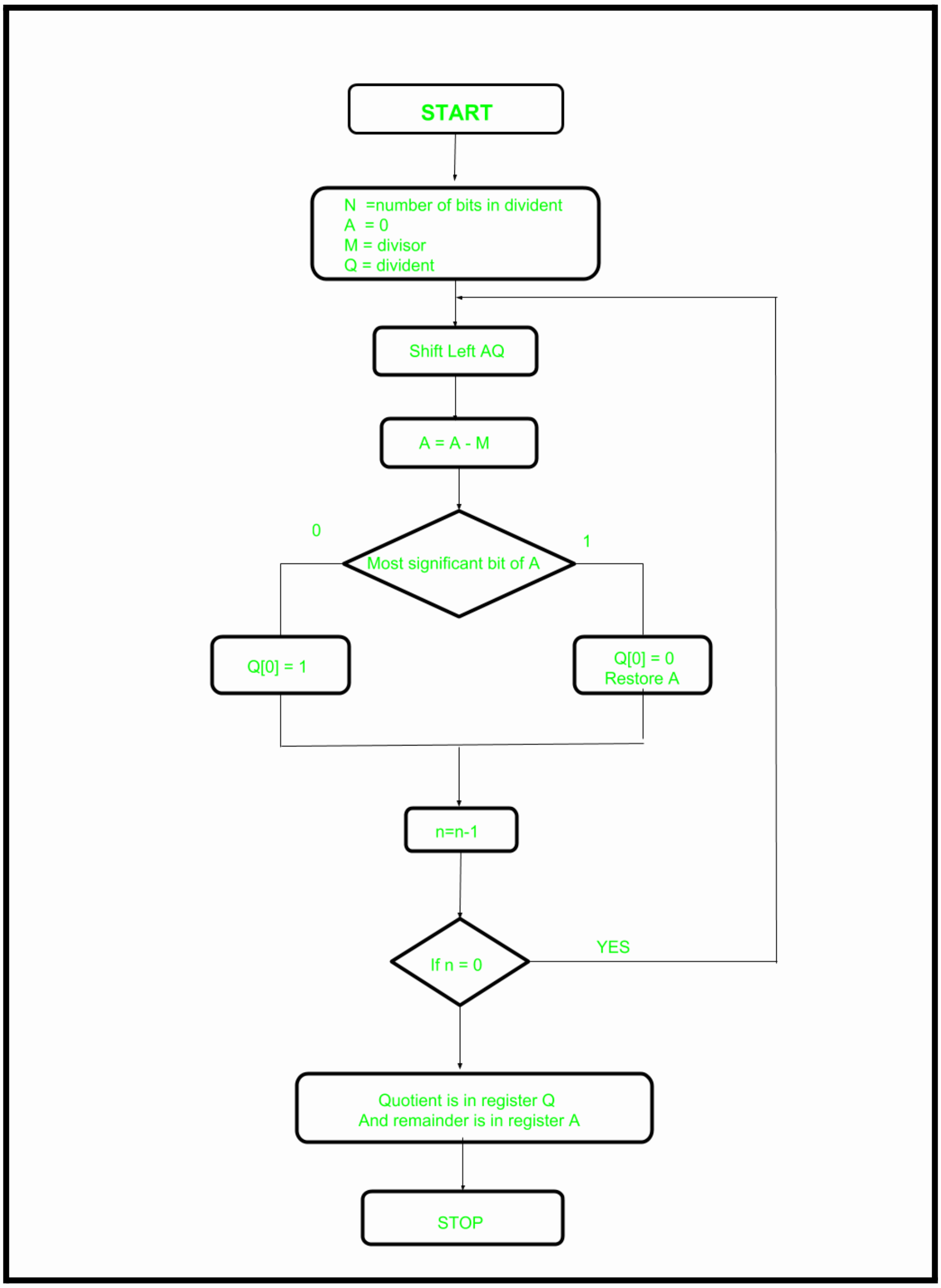
THEORY:

A division algorithm provides a quotient and a remainder when we divide two number. They are generally of two type **slow algorithm and fast algorithm**. Slow division algorithm are restoring, non-restoring, non-performing restoring, SRT algorithm and under fast comes Newton–Raphson and Goldschmidt.

In this article, will be performing restoring algorithm for unsigned integer. Restoring term is due to fact that value of register A is restored after each iteration.



Here, register Q contain quotient and register A contain remainder. Here, n-bit dividend is loaded in Q and divisor is loaded in M. Value of Register is initially kept 0 and this is the register whose value is restored during iteration due to which it is named Restoring.



Let's pick the step involved:

- **Step-1:** First the registers are initialized with corresponding values (Q = Dividend, M = Divisor, A = 0, n = number of bits in dividend)
- **Step-2:** Then the content of register A and Q is shifted right as if they are a single unit
- **Step-3:** Then content of register M is subtracted from A and result is stored in A
- **Step-4:** Then the most significant bit of the A is checked if it is 0 the least significant bit of Q is set to 1 otherwise if it is 1 the least significant bit of Q is set to 0 and value of register A is restored i.e the value of A before the subtraction with M
- **Step-5:** The value of counter n is decremented
- **Step-6:** If the value of n becomes zero we get of the loop otherwise we repeat fro step 2
- **Step-7:** Finally, the register Q contain the quotient and A contain remainder

Examples:

Perform Division Restoring Algorithm
Dividend = 11

Divisor = 3

n	M	A	Q	Operation
4	00011	00000	1011	initialize
	00011	00001	011_	shift left AQ
	00011	11110	011_	A=A-M
	00011	00001	0110	Q[0]=0 And restore A
3	00011	00010	110_	shift left AQ
	00011	11111	110_	A=A-M
	00011	00010	1100	Q[0]=0
2	00011	00101	100_	shift left AQ
	00011	00010	100_	A=A-M
	00011	00010	1001	Q[0]=1
1	00011	00101	001_	shift left AQ
	00011	00010	001_	A=A-M
	00011	00010	0011	Q[0]=1

Remember to restore the value of A, most significant bit of A is 1. As that register Q contains the quotient, i.e. 3 and register A contains remainder 2.

CODE:

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
```

```
int getsize(int x)
{
int c;
if(x<=1)
c = 2;
else if(x < 4)
c = 2;
else if(x< 8)
c = 3;
else if(x< 16)
c = 4;
else if(x< 32)
c = 5;
else if(x< 64)
c = 6;
else if(x< 128)
c = 7;
else if(x< 256)
c = 8;
else if(x< 512)
c = 9;
return c;
}

int max(int x,int y)
{
if(x< y)
return(y);
else
return(x);
}

void main()
{
int B,Q,Z,M,c,c1,e,f,g,h,i,j,x,y,ch,in,S,G,P;
int a[24],b[12],b1[12],q[12],carry=0,count=0,option;
long num;

printf("¦\t\tPROGRAM FOR RESTORING DIVISION\t\t¦\n");
```

```
printf("\n\nENTER DIVIDEND\t: ");
scanf("%d",&Q);
y = getsize(Q);
printf("ENTER DIVISOR\t: ");
scanf("%d",&M);
x = getsize(M);
Z = max(x,y);
printf("\n\tTOTAL BITS CONSIDERED FOR RESULT => %d",2*Z+1);
printf("\n\tINITiALLY A IS RESET TO ZERO:");
for(i=0;i<=Z;i++)
printf("%d ",a[i]=0);
for(i=Z;i>=0;i–)
{
b1[i] = b[i] = M%2;
M = M/2;
b1[i] = 1-b1[i];
}
carry = 1;
for(i=Z;i>=0;i–)
{
c1 = b1[i]^carry;
carry = b1[i]&&carry;
b1[i]=c1;
}
for(i=2*Z;i>Z;i–)
{
a[i] = Q%2;
Q = Q/2;
}
printf("\n\n\tDivisor\t\t(M)\t: ");
for(i=0;i<=Z;i++)
printf("%d ",b[i]);
printf("\n\t2'C Divisor\t(-M)\t: ");
for(i=0;i<=Z;i++)
printf("%d ",b1[i]);
printf("\n\tDividend\t(Q)\t: ");
for(i=Z+1;i<=2*Z;i++)
printf("%d ",a[i]);
printf("\n\n\tBITS CONSIDERED:[ A ]\t [ M ]");
```

```
printf("\n\t\t\t");
for(i=0;i<=Z;i++)
printf("%d ",a[i]);
printf(" ");
for(i=Z+1;i<=2*Z;i++)
printf("%d ",a[i]);
count = Z;
do{
for(i=0;i<2*Z;i++)
a[i] = a[i+1];
printf("\n\nLeft Shift\t\t");
for(i=0;i<=Z;i++)
printf("%d ",a[i]);
printf(" ");
for(i=Z+1;i< 2*Z;i++)
printf("%d ",a[i]);
carry=0;
for(i=Z;i>=0;i–)
{
S=a[i]^(b1[i]^carry);
G=a[i]&&b1[i];
P=a[i]^b1[i];
carry=G||(P&&carry);
a[i]=S ;
}
printf("\nA< -A-M \t\t");
for(i=0;i<=Z;i++)
printf("%d ",a[i]);
printf(" ");
for(i=Z+1;i< 2*Z;i++)
printf("%d ",a[i]);
ch=a[0];
printf("\nBIT Q:%d",ch);
switch (ch)
{
case 0: a[2*Z]=1;
printf(" Q0< -1\t\t");
for(i=0;i<=Z;i++)
printf("%d ",a[i]);
```

```
printf(" ");
for(i=Z+1;i<=2*Z;i++)
printf("%d ",a[i]);
break;

case 1: a[2*Z]=0;
printf(" Q0< -0\t\t");
for(i=0;i<=Z;i++)
printf("%d ",a[i]);
printf(" ");
for(i=Z+1;i< 2*Z;i++)
printf("%d ",a[i]);
carry=0;
for(i=Z;i>=0;i--)
{
S=a[i]^(b[i]^carry);
G=a[i]&&b[i];
P=a[i]^b[i];
carry=G||(P&&carry);
a[i]=S ;
}
printf("\nA< -A+M");
printf("\t\t\t");
for(i=0;i<=Z;i++)
printf("%d ",a[i]);
printf(" ");
for(i=Z+1;i<=2*Z;i++)
printf("%d ",a[i]);
break;
}
count--;
}while(count!=0);
num=0;
printf("\n\n\t\tQUOTIENT IN BITS :");
for(i=Z+1;i<=2*Z;i++)
{
printf("%d ",a[i]);
num=num+pow(2,2*Z-i)*a[i];
}
```

```
printf("\n\t\tOUOTIENT IN DECIMAL :%ld",num);
num=0;
printf("\n\t\tREMAINDER IN BITS :");
for(i=0;i<=Z;i++)
{
printf("%d ",a[i]);
num=num+pow(2,Z-i)*a[i];
}
printf("\n\t\tREMAINDER IN DECIMAL :%ld",num);
getch();

getch();
}
```

OUTPUT:

```
¦                PROGRAM FOR RESTORING DIVISION                ¦


ENTER DIVIDEND  : 17
ENTER DIVISOR   : 4

        TOTAL BITS CONSIDERED FOR RESULT => 11
        INITiALLY A IS RESET TO ZERO:0 0 0 0 0 0

        Divisor         (M)     : 0 0 0 1 0 0
        2'C Divisor     (-M)    : 1 1 1 1 0 0
        Dividend        (Q)     : 1 0 0 0 1

        BITS CONSIDERED:[ A ]    [ M ]
                        0 0 0 0 0 0  1 0 0 0 1

Left Shift              0 0 0 0 0 1  0 0 0 1
A< -A-M                 1 1 1 1 0 1  0 0 0 1
BIT Q:1 Q0< -0          1 1 1 1 0 1  0 0 0 1
A< -A+M                 0 0 0 0 0 1  0 0 0 1 0

Left Shift              0 0 0 0 1 0  0 0 1 0
A< -A-M                 1 1 1 1 1 0  0 0 1 0
BIT Q:1 Q0< -0          1 1 1 1 1 0  0 0 1 0
A< -A+M                 0 0 0 0 1 0  0 0 1 0 0

Left Shift              0 0 0 1 0 0  0 1 0 0
A< -A-M                 0 0 0 0 0 0  0 1 0 0
BIT Q:0 Q0< -1          0 0 0 0 0 0  0 1 0 0 1

Left Shift              0 0 0 0 0 0  1 0 0 1
A< -A-M                 1 1 1 1 0 0  1 0 0 1
BIT Q:1 Q0< -0          1 1 1 1 0 0  1 0 0 1
A< -A+M                 0 0 0 0 0 0  1 0 0 1 0

Left Shift              0 0 0 0 0 1  0 0 1 0
A< -A-M                 1 1 1 1 0 1  0 0 1 0
BIT Q:1 Q0< -0          1 1 1 1 0 1  0 0 1 0
A< -A+M                 0 0 0 0 0 1  0 0 1 0 0

                QUOTIENT IN BITS :0 0 1 0 0
                QUOTIENT IN DECIMAL :4
                REMAINDER IN BITS :0 0 0 0 0 1
                REMAINDER IN DECIMAL :1
```

CONCLUSION: From this experiment, we learn how to use the restoring division algorithm to divide unsigned bits. We understood that it is a type of slow algorithm along with non-restoring division. We also learn how to write the code for the same algorithm in C language and implement it successfully.