



Vidyavardhini's College of Engineering and Technology

Department of Artificial Intelligence & Data Science

Experiment No. 8
Implement Restoring algorithm using c-programming
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Aim: To implement Restoring division algorithm using c-programming.

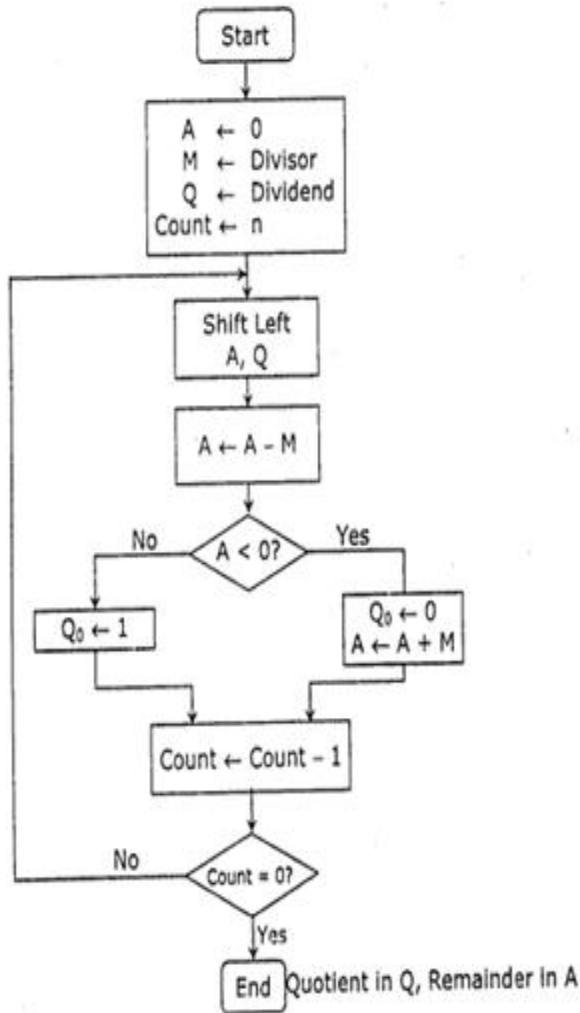
Objective -

1. To understand the working of Restoring division algorithm.
2. To understand how to implement Restoring division algorithm using c-programming.

Theory:

- 1) The divisor is placed in M register, the dividend placed in Q register.
- 2) At every step, the A and Q registers together are shifted to the left by 1-bit
- 3) M is subtracted from A to determine whether A divides the partial remainder. If it does, then Q0 set to 1-bit. Otherwise, Q0 gets a 0 bit and M must be added back to A to restore the previous value.
- 4) The count is then decremented and the process continues for n steps. At the end, the quotient is in the Q register and the remainder is in the A register.

Flowchart



Perform $8 + 3$ by restoring division technique.

	A Register	Q Register
Initially	0 0 0 0	1 0 0 0
Shift	0 0 0 1	0 0 0 □
Subtract M	1 1 1 0 1	
Set Q ₀	① 1 1 1 0	
Restore(A+M)	0 0 0 1 1	
	0 0 0 1	0 0 0 ①
Shift	0 0 0 1 0	0 0 ① □
Subtract M	1 1 1 0 1	
Set Q ₀	① 1 1 1 1	
Restore(A+M)	0 0 0 1 1	
	0 0 0 1 0	0 0 ① ①
Shift	0 0 1 0 0	0 ① ① □
Subtract M	1 1 1 0 1	
Set Q ₀	① 0 0 0 1	
Shift	0 0 0 1 0	0 0 ① ①
Subtract M	1 1 1 0 1	① ① ① □
Set Q ₀	① 1 1 1 1	
Restore(A+M)	0 0 0 1 1	
	0 0 0 1 0	① ① ① ①
	Remainder	Quotient

Program-

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

```
#include <stdlib.h>
```

```
int dec_bin(int, int []);
```

```
int twos(int [], int []);
```

```
int left(int [], int []);
```

```
int add(int [], int []);
```

```
int main()
```

```
{
```

```
    int a, b, m[4]={0,0,0,0}, q[4]={0,0,0,0}, acc[4]={0,0,0,0}, m2[4], i, n=4;
```

```
    printf("Enter the Dividend: ");
```



```
scanf("%d", &a);
printf("Enter the Divisor: ");
scanf("%d", &b);
dec_bin(a, q);
dec_bin(b, m);
twos(m, m2);
printf("\nA\tQ\tComments\n");
for(i=3; i>=0; i--)
{
    printf("%d", acc[i]);
}
printf("\t");
for(i=3; i>=0; i--)
{
    printf("%d", q[i]);
}
printf("\tStart\n");
while(n>0)
{
    left(acc, q);
    for(i=3; i>=0; i--)
    {
        printf("%d", acc[i]);
    }
    printf("\t");
    for(i=3; i>=1; i--)
    {
        printf("%d", q[i]);
    }
    printf("_\tLeft Shift A,Q\n");
    add(acc, m2);
    for(i=3; i>=0; i--)
    {
        printf("%d", acc[i]);
    }
    printf("\t");
    for(i=3; i>=1; i--)
    {
        printf("%d", q[i]);
    }
}
```



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```
}
printf("_\tA=A-M\n");
if(acc[3]==0)
{
    q[0]=1;
    for(i=3; i>=0; i--)
    {
        printf("%d", acc[i]);
    }
    printf("\t");
    for(i=3; i>=0; i--)
    {
        printf("%d", q[i]);
    }
    printf("\tQo=1\n");
}
else
{
    q[0]=0;
    add(acc, m);
    for(i=3; i>=0; i--)
    {
        printf("%d", acc[i]);
    }
    printf("\t");
    for(i=3; i>=0; i--)
    {
        printf("%d", q[i]);
    }
    printf("\tQo=0; A=A+M\n");
}
n--;
}
printf("\nQuotient = ");
for(i=3; i>=0; i--)
{
    printf("%d", q[i]);
}
printf("\tRemainder = ");
```



```
for(i=3; i>=0; i--)
{
    printf("%d", acc[i]);
}
printf("\n");
return 0;
}
```

```
int dec_bin(int d, int m[])
{
    int b=0, i=0;
    for(i=0; i<4; i++)
    {
        m[i]=d%2;
        d=d/2;
    }
    return 0;
}
```

```
int twos(int m[], int m2[])
{
    int i, m1[4];
    for(i=0; i<4; i++)
    {
        if(m[i]==0)
        {
            m1[i]=1;
        }
        else
        {
            m1[i]=0;
        }
    }
    for(i=0; i<4; i++)
    {
        m2[i]=m1[i];
    }
    if(m2[0]==0)
    {

```



```
m2[0]=1;
}
else
{
    m2[0]=0;
    if(m2[1]==0)
    {
        m2[1]=1;
    }
    else
    {
        m2[1]=0;
        if(m2[2]==0)
        {
            m2[2]=1;
        }
        else
        {
            m2[2]=0;
            if(m2[3]==0)
            {
                m2[3]=1;
            }
            else
            {
                m2[3]=0;
            }
        }
    }
}
return 0;
}
```

```
int left(int acc[], int q[])
{
    int i;
    for(i=3; i>0; i--)
    {
        acc[i]=acc[i-1];
    }
}
```



```
}
acc[0]=q[3];
for(i=3; i>0; i--)
{
    q[i]=q[i-1];
}
}

int add(int acc[], int m[])
{
    int i, carry=0;
    for(i=0; i<4; i++)
    {
        if(acc[i]+m[i]+carry==0)
        {
            acc[i]=0;
            carry=0;
        }
        else if(acc[i]+m[i]+carry==1)
        {
            acc[i]=1;
            carry=0;
        }
        else if(acc[i]+m[i]+carry==2)
        {
            acc[i]=0;
            carry=1;
        }
        else if(acc[i]+m[i]+carry==3)
        {
            acc[i]=1;
            carry=1;
        }
    }
    return 0;
}
```



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Output -

Enter the Dividend: 12

Enter the Divisor: 2

A	Q	Comments
0000	1100	Start
0001	100_	Left Shift A,Q
1111	100_	A=A-M
0001	1000	Qo=0; A=A+M
0011	000_	Left Shift A,Q
0001	000_	A=A-M
0001	0001	Qo=1
0010	001_	Left Shift A,Q
0000	001_	A=A-M
0000	0011	Qo=1
0000	011_	Left Shift A,Q
1110	011_	A=A-M
0000	0110	Qo=0; A=A+M

Quotient = 0110 Remainder = 0000

Conclusion -

The Restoring Division Algorithm is a method used for performing integer division in computer arithmetic. It stands as an important approach that allows the division of binary numbers using a systematic and sequential process. By iteratively performing subtraction and shifting operations, the algorithm provides a reliable means to achieve quotient and remainder outputs. The Restoring Division Algorithm's significance lies in its use as a foundational concept in understanding division techniques and in educational contexts for teaching computer arithmetic and digital logic design.