Experiment No. 9
Implement Non-Restoring algorithm using c-programming
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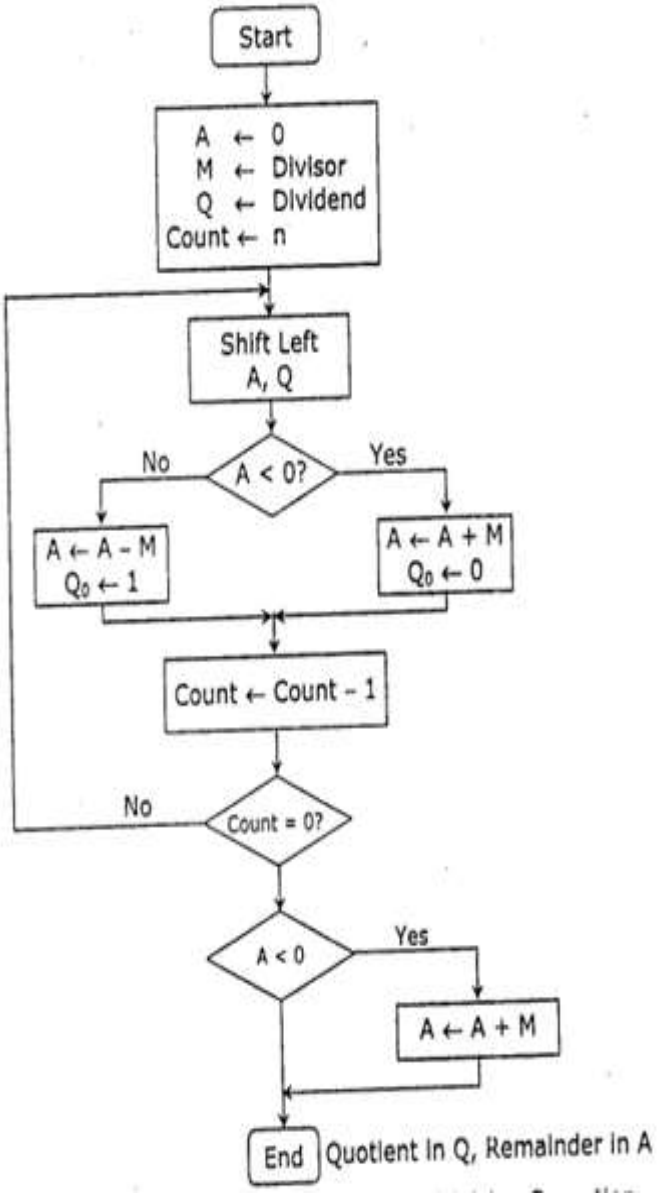
Aim - To implement Non-Restoring division algorithm using c-programming.

Objective -

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

Theory:

In each cycle content of the register, A is first shifted and then the divisor is added or subtracted with the content of register A depending upon the sign of A. In this, there is no need of restoring, but if the remainder is negative then there is a need of restoring the remainder. This is the faster algorithm of division.



Perform 8 ÷ 3 by non-restoring division technique.

	A Register	Q Register	
Initially	0 0 0 0 0	1 0 0 0	
Shift	0 0 0 0 1	0 0 0 □	
Subtract	1 1 1 0 1		First Cycle
Set Q_0	① 1 1 1 0	0 0 0 0	
Shift	1 1 1 0 0	0 0 0 □	
Add	0 0 0 1 1		
Set Q_0	① 1 1 1 1	0 0 0 0	Second Cycle
Shift	1 1 1 1 0	0 0 0 □	
Add	0 0 0 1 1		
Set Q_0	⓪ 0 0 0 1	0 0 0 1	Third Cycle
Shift	0 0 0 1 0	0 0 1 □	
Subtract	1 1 1 0 1		
Set Q_0	① 1 1 1 1	0 0 1 0	Fourth Cycle
			Quotient
Add	1 1 1 1 1		
	0 0 0 1 1		
	0 0 0 1 0		
	Remainder		

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]);
}
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;
}
```

Output:

```
Enter the Dividend: 10
Enter the Divisor: 2
A       Q       Comments
0000    1010    Start
0001    010_    Left Shift A,Q
1111    010_    A=A-M
0001    0100    Qo=0; A=A+M
0010    100_    Left Shift A,Q
0000    100_    A=A-M
0000    1001    Qo=1
0001    001_    Left Shift A,Q
1111    001_    A=A-M
0001    0010    Qo=0; A=A+M
0010    010_    Left Shift A,Q
0000    010_    A=A-M
0000    0101    Qo=1

Quotient = 0101        Remainder = 0000
```

Conclusion –

The Non-Restoring Division Algorithm is an alternative method for binary division, sharing some similarities with the Restoring Division Algorithm but with a distinct approach to handling negative remainders. It's a commonly employed technique in digital systems and microprocessors for effective binary division.
The following C program demonstrates the fundamental concepts of the Non-Restoring Division Algorithm by carrying out binary division using a given dividend and divisor. It follows the essential algorithmic steps, such as left-shifting, subtracting, determining quotient bits, and making corrections as necessary. The program's output provides both the quotient and the remainder, which collectively represent the result of the division operation.