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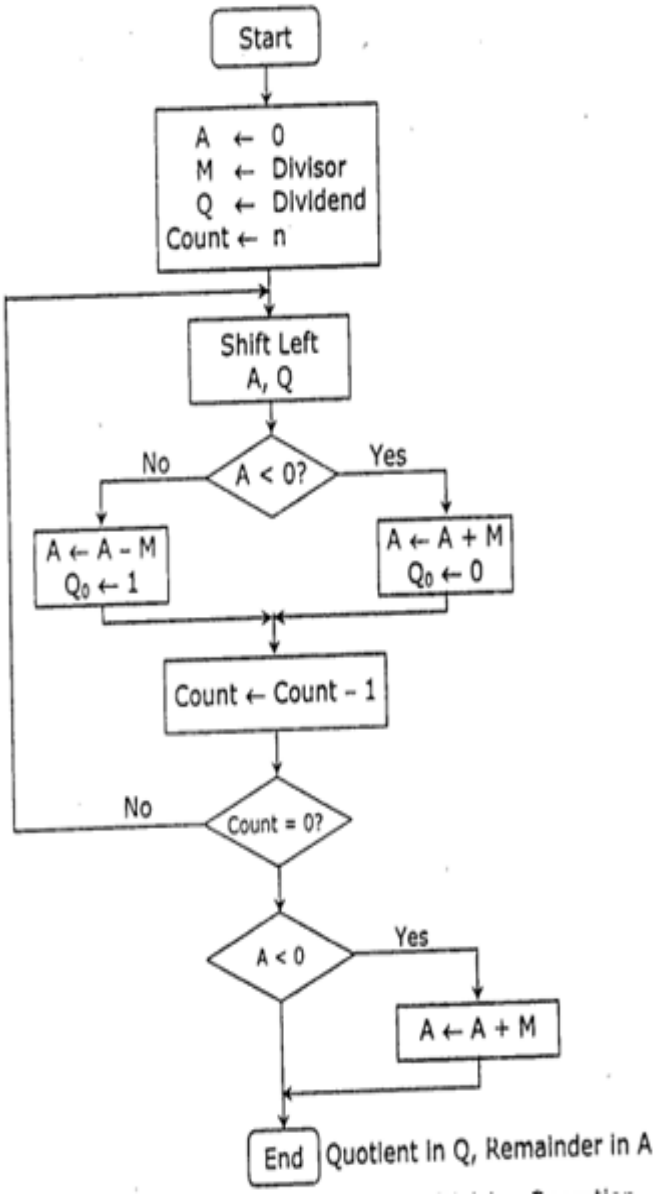
Aim - To implement Non-Restoring division algorithm using c-programming.

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	First Cycle
Shift	0 0 0 0 1	0 0 0 □	
Subtract	1 1 1 0 1		
Set Q_0	① 1 1 1 0	0 0 0 0	
Shift	1 1 1 0 0	0 0 0 □	Second Cycle
Add	0 0 0 1 1		
Set Q_0	① 1 1 1 1	0 0 0 0	
Shift	1 1 1 1 0	0 0 0 □	Third Cycle
Add	0 0 0 1 1		
Set Q_0	⓪ 0 0 0 1	0 0 0 1	
Shift	0 0 0 1 0	0 0 1 □	Fourth Cycle
Subtract	1 1 1 0 1		
Set Q_0	① 1 1 1 1	0 0 1 0	
Add	1 1 1 1 1		Quotient
	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 represents a significant improvement over the Restoring Division Algorithm, offering a more efficient approach to perform integer division in computer arithmetic. Its primary advantage lies in reducing the number of iterations and operations required to produce the quotient and remainder when dividing binary numbers. the Non-Restoring Division Algorithm stands as a significant advancement in the realm of computer arithmetic, providing a more efficient and faster means of performing integer division. Its application in processor design and digital circuitry showcases its relevance in optimizing computational efficiency.