Experiment No. 9
Aim : Implement Non-Restoring algorithm using c-programming
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Date of Performance:
Date of Submission:

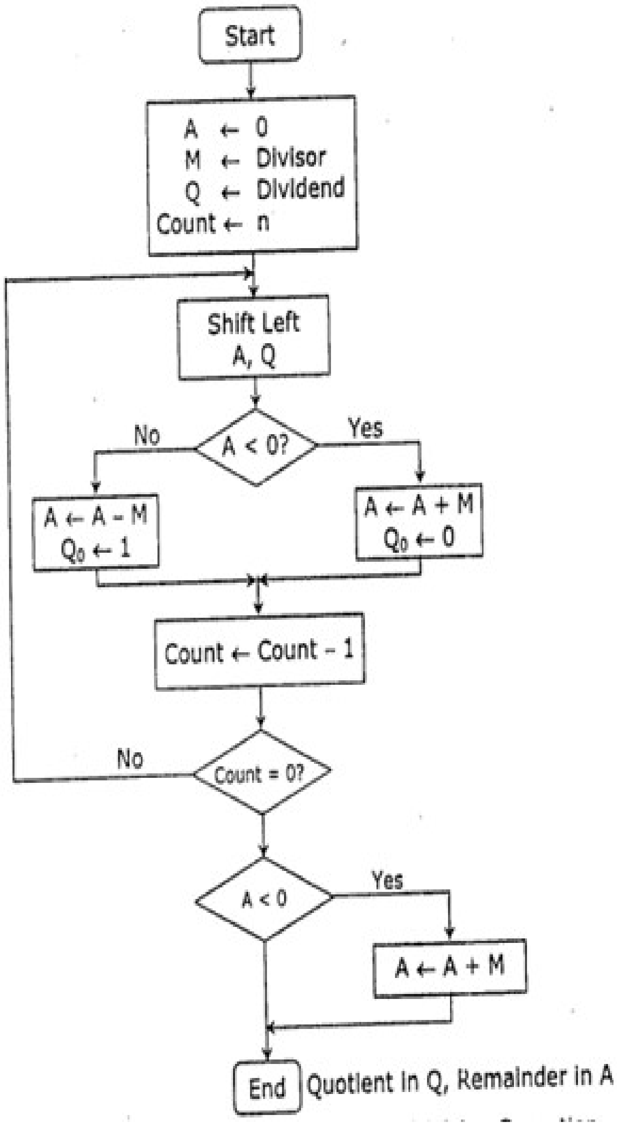
Aim - To implement Non-Restoring division algorithm using c-programming.

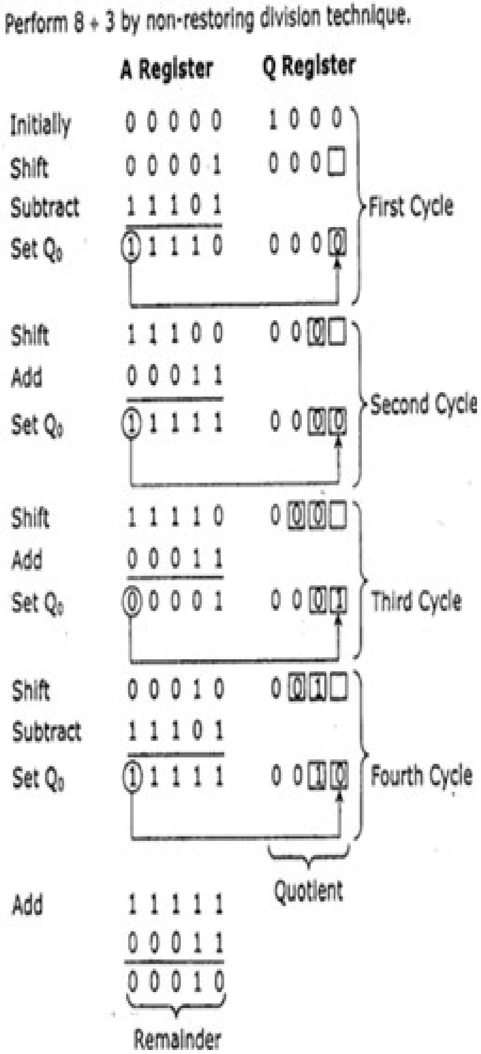
Objective -

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	
		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: 5
A      Q      Comments
0000   1010   Start
0001   010_   Left Shift A,Q
1100   010_   A=A-M
0001   0100   Qo=0; A=A+M
0010   100_   Left Shift A,Q
1101   100_   A=A-M
0010   1000   Qo=0; A=A+M
0101   000_   Left Shift A,Q
0000   000_   A=A-M
0000   0001   Qo=1
0000   001_   Left Shift A,Q
1011   001_   A=A-M
0000   0010   Qo=0; A=A+M

Quotient = 0010      Remainder = 0000
```

Conclusion –

The experiment demonstrated the design and implementation of a non-restoring division algorithm, which is a type of logic circuit that can divide two n-bit binary numbers by using repeated shifting, addition, and subtraction operations.The experiment used integrated circuits (ICs) to implement the registers and the arithmetic logic unit (ALU) on a breadboard, and verified their functionality using a multimeter or an oscilloscope.The experiment recorded the input and output values of each register and the ALU for different combinations of binary inputs and constructed the corresponding truth tables.