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

Objective -

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

Theory:

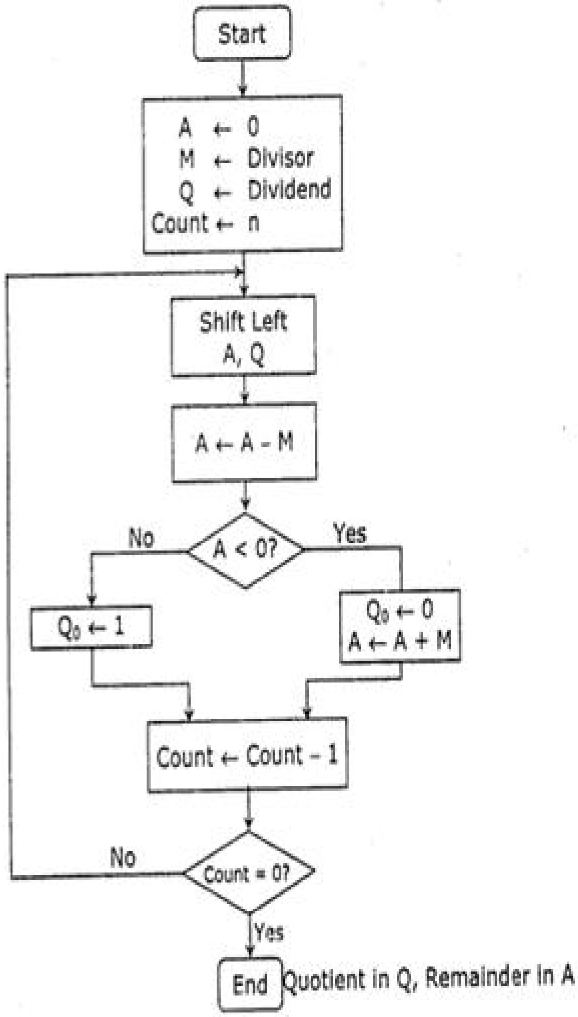
1) The divisor is placed in M register, the dividend placed in Q register.

2) At every step, the A and Q registers together are shifted to the left by 1-bit

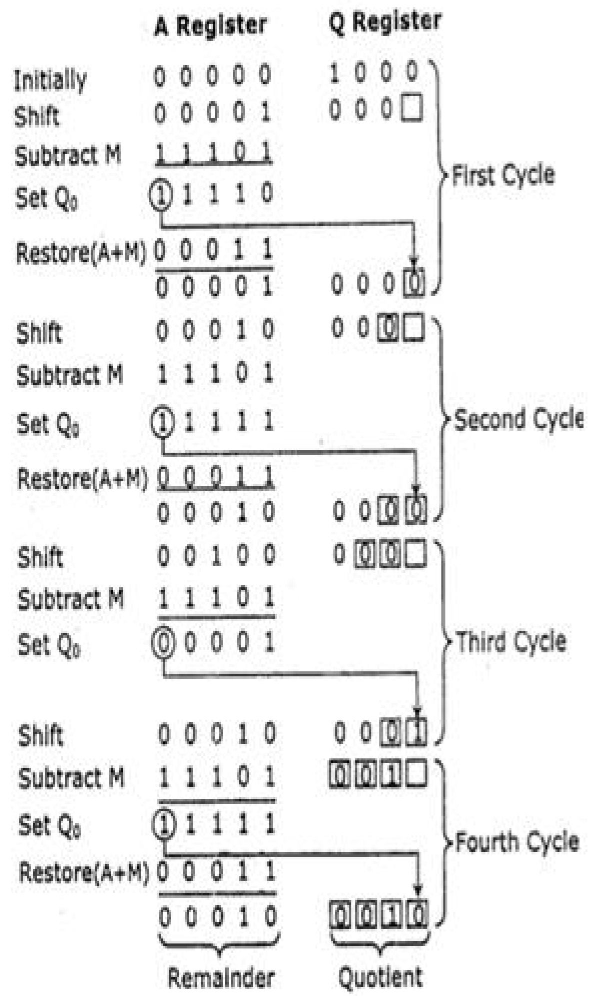
3) M is subtracted from A to determine whether A divides the partial remainder. If it does, then Q0 is set to 1-bit. Otherwise, Q0 gets a 0 bit and M must be added back to A to restore the previous value.

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 0	1 0 0 0	First Cycle
Shift	0 0 0 0 1	0 0 0 □	
Subtract M	1 1 1 0 1		
Set Q₀	1 1 1 1 0		
Restore(A+M)	0 0 0 1 1		
	0 0 0 0 1	0 0 0 0	
Shift	0 0 0 1 0	0 0 0 □	Second Cycle
Subtract M	1 1 1 0 1		
Set Q₀	1 1 1 1 1		
Restore(A+M)	0 0 0 1 1		
	0 0 0 1 0	0 0 0 0	
Shift	0 0 1 0 0	0 0 0 □	Third Cycle
Subtract M	1 1 1 0 1		
Set Q₀	0 0 0 0 1		
Shift	0 0 0 1 0	0 0 0 1	
Subtract M	1 1 1 0 1	0 0 1 □	Fourth Cycle
Set Q₀	1 1 1 1 1		
Restore(A+M)	0 0 0 1 1		
	0 0 0 1 0	0 0 1 0	
	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]);
}
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;
            }
        }
    }
}
```

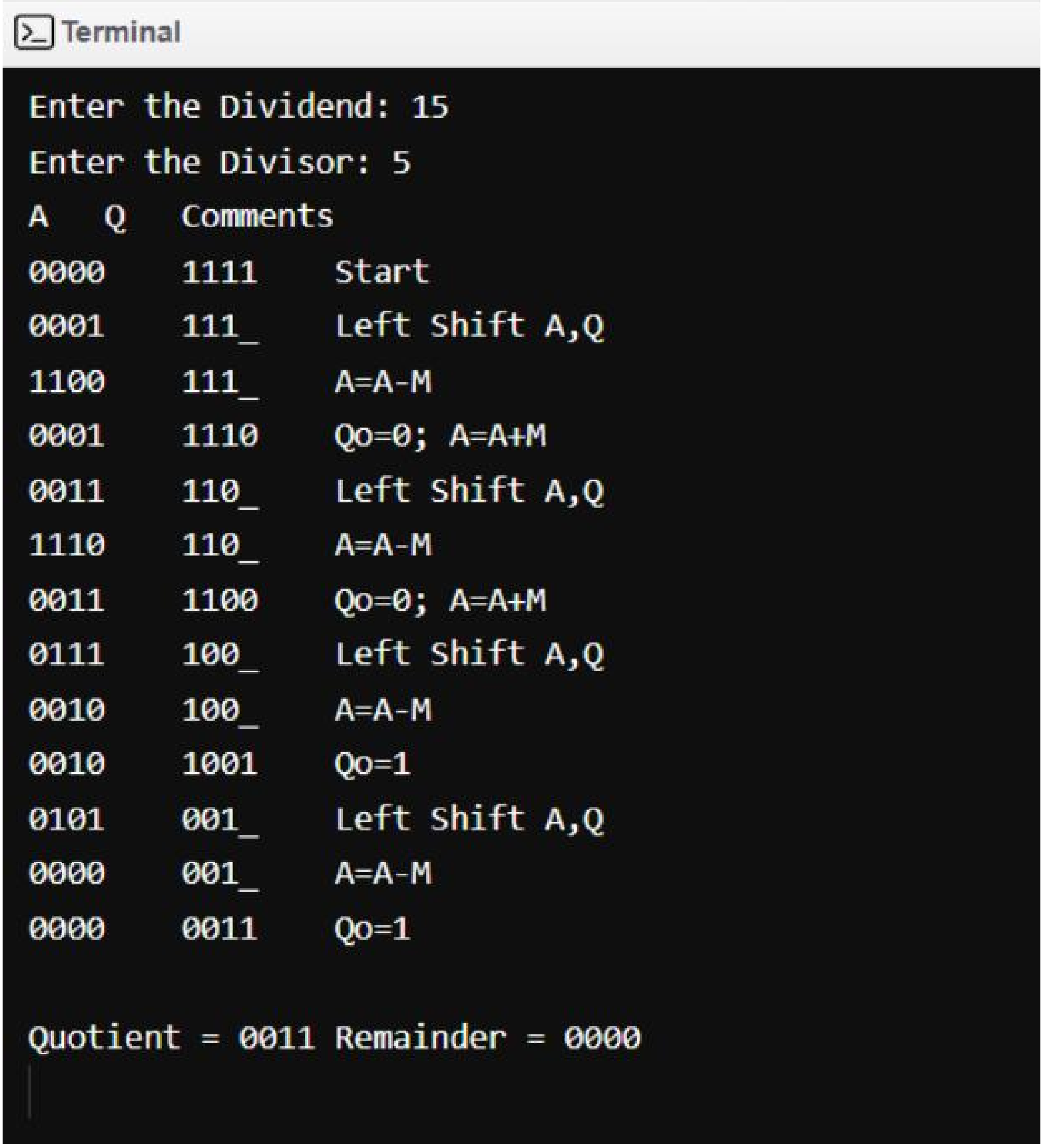
```
  return 0;
}


+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: 15
Enter the Divisor: 5
A   Q   Comments
0000    1111    Start
0001    111_    Left Shift A,Q
1100    111_    A=A-M
0001    1110    Qo=0; A=A+M
0011    110_    Left Shift A,Q
1110    110_    A=A-M
0011    1100    Qo=0; A=A+M
0111    100_    Left Shift A,Q
0010    100_    A=A-M
0010    1001    Qo=1
0101    001_    Left Shift A,Q
0000    001_    A=A-M
0000    0011    Qo=1

Quotient = 0011 Remainder = 0000
```

Conclusion -

In conclusion, this experiment successfully implemented the Restoring Division algorithm using C programming. The Restoring Division algorithm is a method for dividing two numbers and determining the quotient and remainder. The C program emulated the algorithm's steps, including left-shifting the dividend and quotient registers, subtracting the divisor from the accumulator, and updating the quotient bit based on whether the accumulator was positive or negative. The program accurately produced the quotient and remainder of the division, providing a practical demonstration of the Restoring Division algorithm's operation. This experiment deepened our understanding of this division technique and its practical implementation, showcasing its importance in computer arithmetic and digital computation.