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

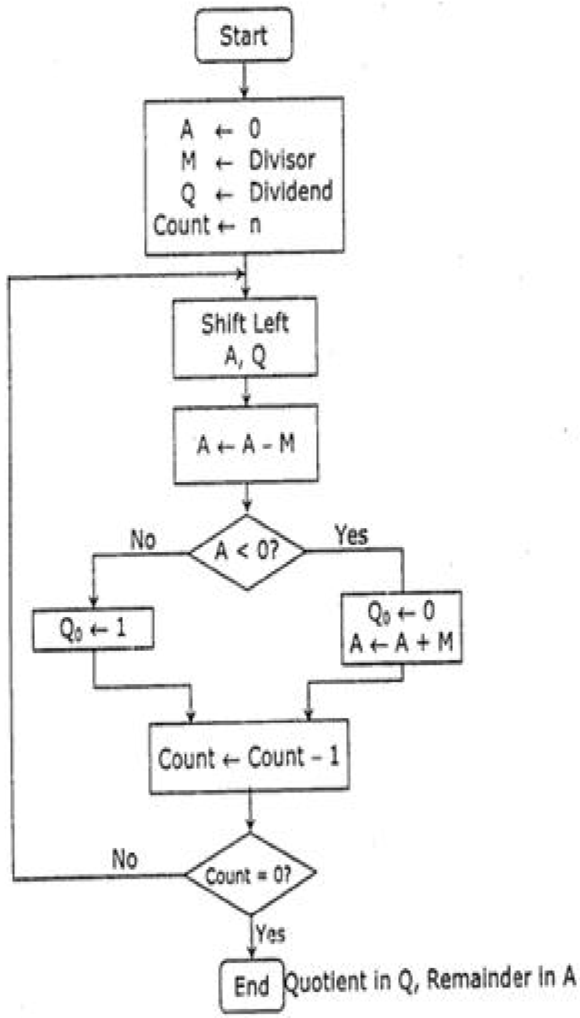
Objective -

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

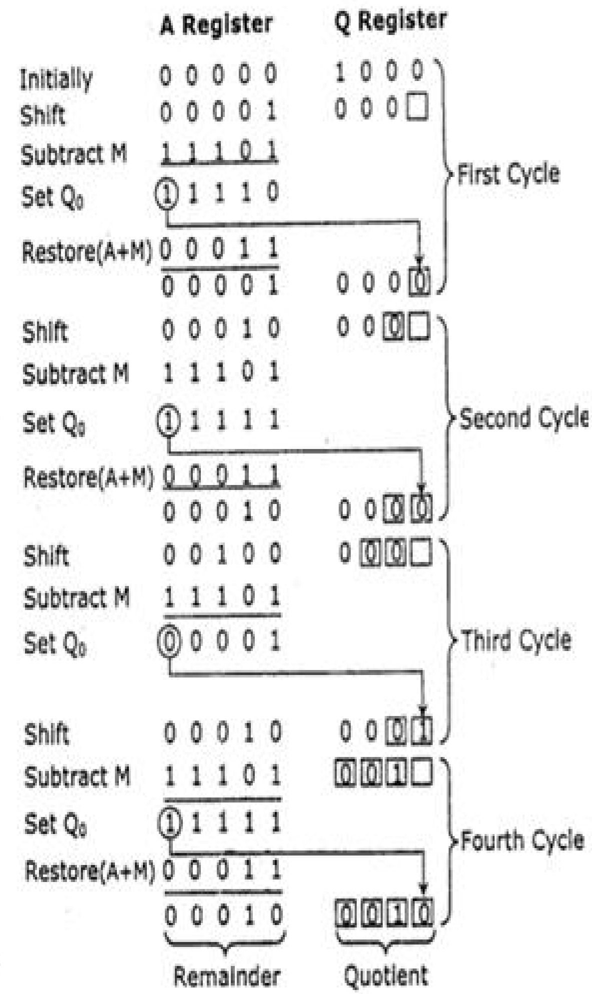
Theory:

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.



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: 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 -
Implementing the Restoring Division Algorithm in C programming is a valuable exercise in understanding computer architecture and low-level operations. This algorithm is essential for integer division and can be optimized for various applications. By mastering it, programmers can improve their skills in bitwise manipulation and algorithm design. However, it's crucial to be diligent in coding, testing, and optimizing to ensure efficient and reliable division operations in real-world applications.