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

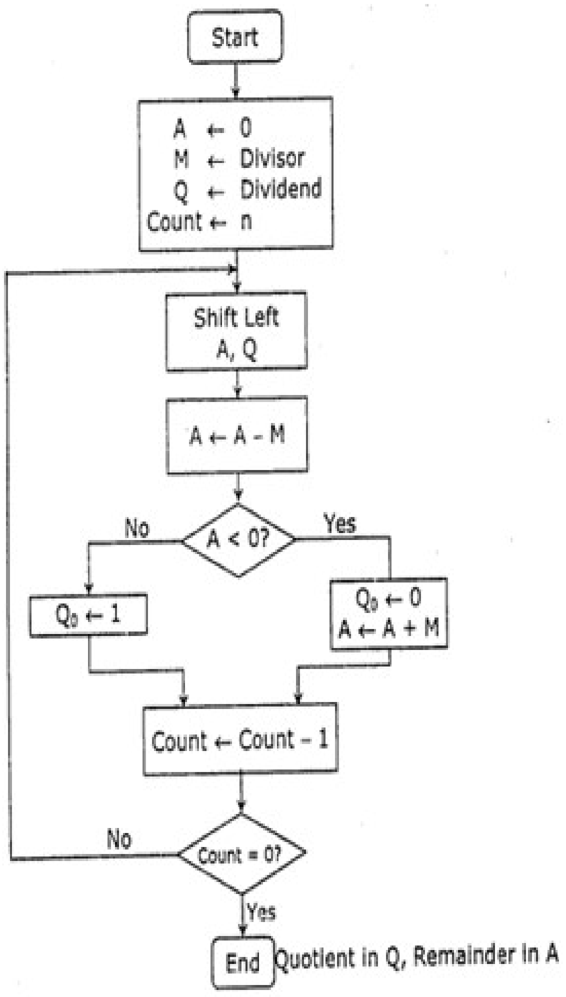
Objective -

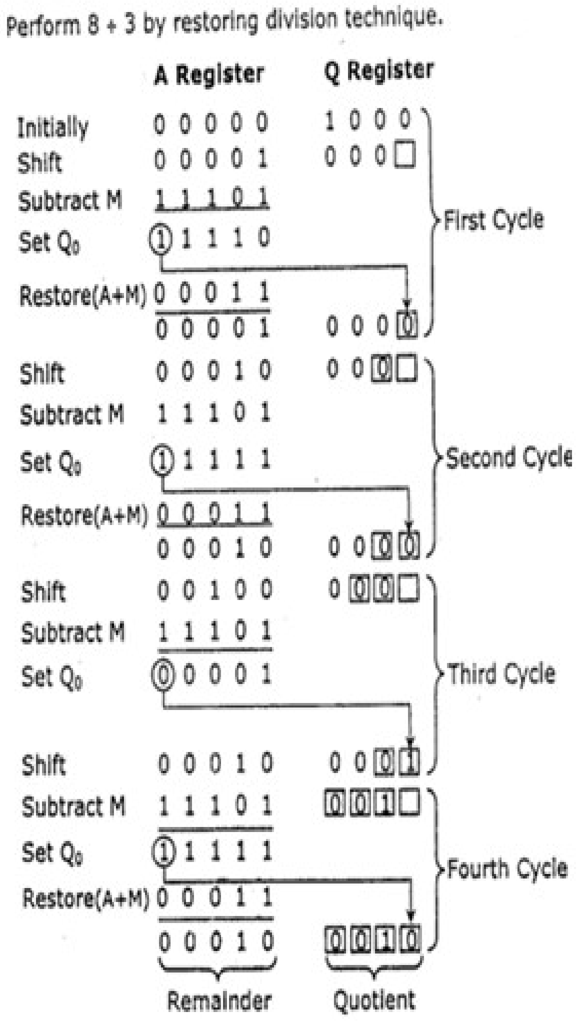
1. To understand the working of Restoring division algorithm.
2. To understand how to implement Restoring division algorithm using c-programming.

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





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 -

The Restoring Division Algorithm is a method for performing binary division that doesn't involve restoring steps when a subtraction results in a negative remainder. Instead, it adjusts the divisor and keeps track of a quotient bit, making it efficient for hardware implementations and digital systems. The Restoring Division Algorithm is often used in digital systems and microprocessors for performing binary division efficiently. Its non-restoring nature minimizes the number of subtraction operations and makes it suitable for hardware implementation.