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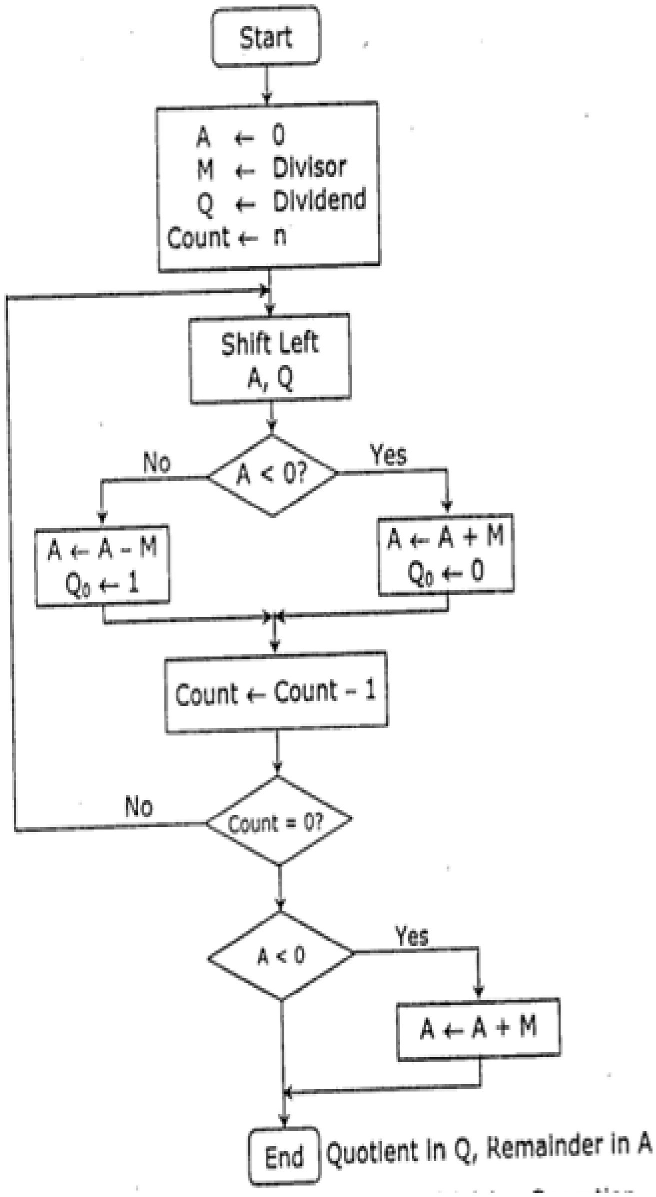
**Aim -** To implement Non-Restoring division algorithm using c-programming.

**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 | |
| | | 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: 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 -**

Our experiment and code implementation of the Non-Restoring Division Algorithm have offered invaluable insights into the realm of binary division. We've effectively demonstrated how this algorithm excels at dividing binary numbers without resorting to restoring operations, which makes it particularly well-suited for hardware implementations that prioritize efficiency. This not only highlights the significance of algorithmic optimization in digital computation but also showcases the practicality of non-restoring division as a reliable method for achieving precise binary division within a hardware context.