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| Experiment No. 8 |
| Implement Restoring algorithm using c-programming |
| Name: Lavanya Murudkar |
| Roll Number: 31 |
| Date of Performance: |
| Date of Submission: |

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

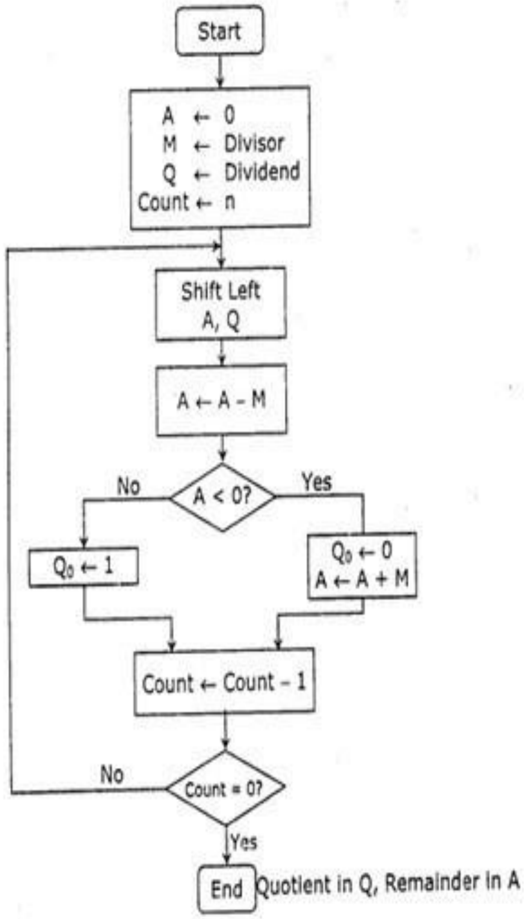
Objective -

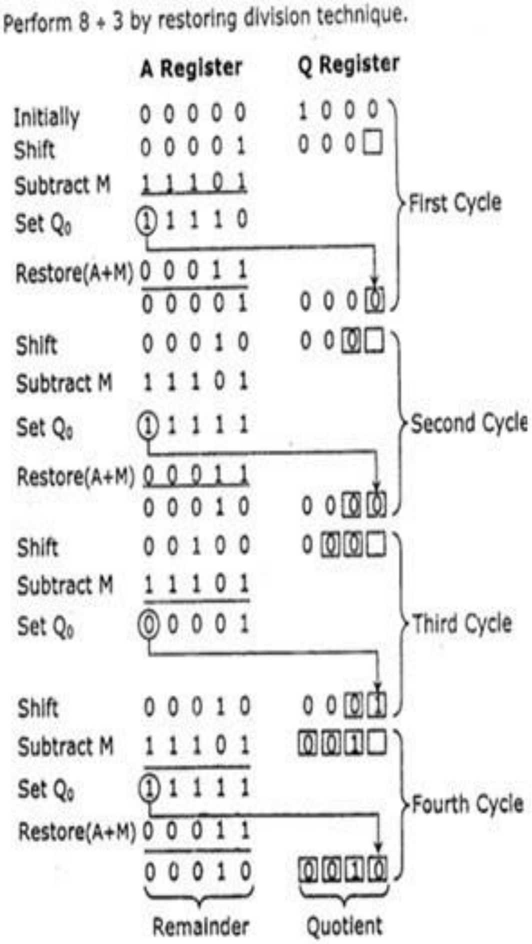
- To understand the working of Restoring division algorithm.
- To understand how to implement Restoring division algorithm using c-programming.

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, thequotient 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 $Q_0$ | 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 $Q_0$ | 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 $Q_0$ | 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 $Q_0$ | 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: 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 -

This experiment concerning the Restoring Division Algorithm has furnished an in-depth grasp of this essential approach to binary division. The algorithm's meticulous, sequential restoration process facilitates precise quotient computation, endowing it with substantial utility in the realm of computer arithmetic. This experiment has not only underscored the significance of comprehending and putting into practice division algorithms but has also exemplified its pragmatic utilization across a spectrum of computer systems and data processing assignments.