Experiment No. 7
Implement Booth's algorithm using c-programming
Name: Nitish Jha
Roll Number: 18
Date of Performance:
Date of Submission:

Aim: To implement Booth's algorithm using c-programming.

Objective -

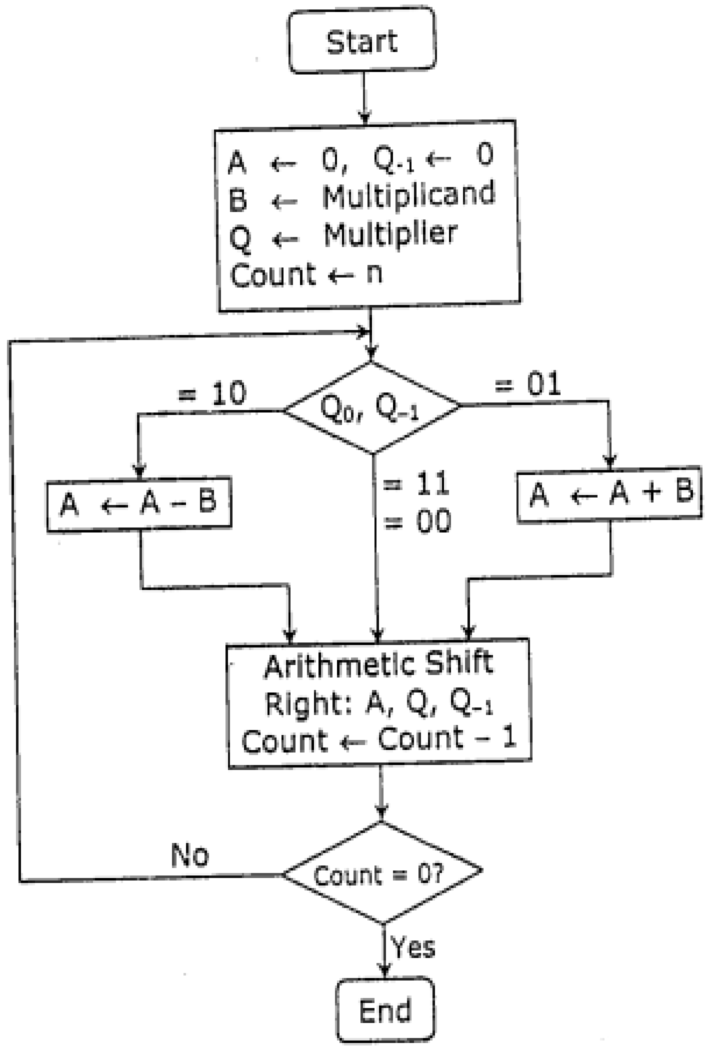
1. To understand the working of Booths algorithm.
2. To understand how to implement Booth's algorithm using c-programming.

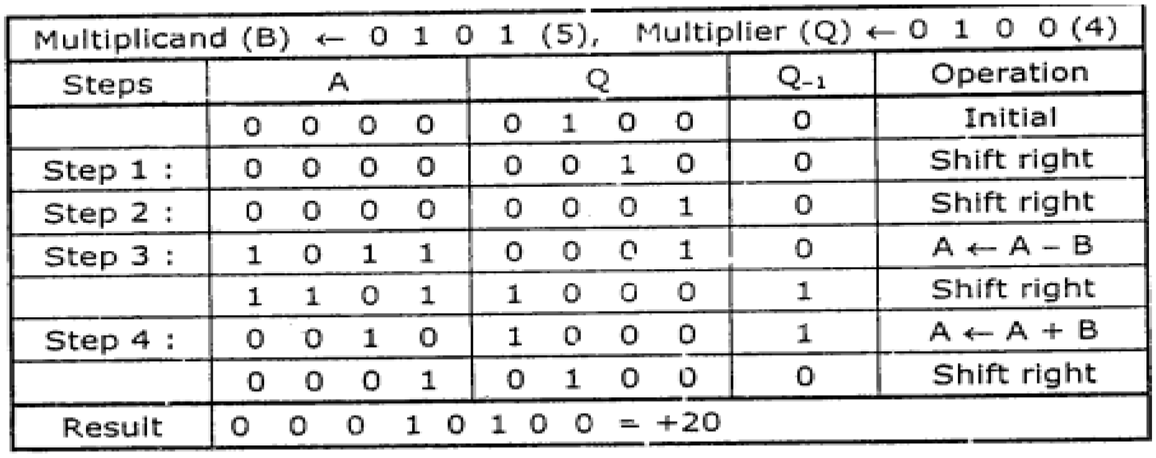
Theory:

Booth's algorithm is a multiplication algorithm that multiplies two signed binary numbers in 2's complement notation. Booth used desk calculators that were faster at shifting than adding and created the algorithm to increase their speed.

The algorithm works as per the following conditions :

1. If Qn and Q_{-1} are same i.e. 00 or 11 perform arithmetic shift by 1 bit.
2. If Qn Q_{-1} = 10 do A= A - B and perform arithmetic shift by 1 bit.
3. If Qn Q_{-1} = 01 do A= A + B and perform arithmetic shift by 1 bit.





Multiplicand (B) ← 0 1 0 1 (5), Multiplier (Q) ← 0 1 0 0 (4)

Steps	A	Q	Q_{-1}	Operation
	0 0 0 0	0 1 0 0	0	Initial
Step 1 :	0 0 0 0	0 0 1 0	0	Shift right
Step 2 :	0 0 0 0	0 0 0 1	0	Shift right
Step 3 :	1 0 1 1	0 0 0 1	0	A ← A − B
	1 1 0 1	1 0 0 0	1	Shift right
Step 4 :	0 0 1 0	1 0 0 0	1	A ← A + B
	0 0 0 1	0 1 0 0	0	Shift right
Result	0 0 0 1 0 1 0 0 = +20			

Program:

```
#include <math.h>

int a = 0,b = 0, c = 0, a1 = 0, b1 = 0, com[5] = { 1, 0, 0, 0, 0};
int anum[5] = {0}, anumcp[5] = {0}, bnum[5] = {0};
int acomp[5] = {0}, bcomp[5] = {0}, pro[5] = {0}, res[5] = {0};

void binary(){
    a1 = fabs(a);
    b1 = fabs(b);
    int r, r2, i, temp;
    for (i = 0; i < 5; i++){
         r = a1 % 2;
         a1 = a1 / 2;
         r2 = b1 % 2;
         b1 = b1 / 2;
         anum[i] = r;
         anumcp[i] = r;
         bnum[i] = r2;
         if(r2 == 0){
             bcomp[i] = 1;
         }
         if(r == 0){
             acomp[i] =1;
         }
    }

  c = 0;
  for ( i = 0; i < 5; i++){
         res[i] = com[i]+ bcomp[i] + c;
         if(res[i] >= 2){
             c = 1;
         }
         else
             c = 0;
         res[i] = res[i] % 2;
    }
  for (i = 4; i >= 0; i--){
    bcomp[i] = res[i];
  }

  if (a < 0){
     c = 0;
    for (i = 4; i >= 0; i--){
          res[i] = 0;
    }
    for ( i = 0; i < 5; i++){
          res[i] = com[i] + acomp[i] + c;
          if (res[i] >= 2){
               c = 1;
          }
          else
               c = 0;
          res[i] = res[i]%2;
    }
    for (i = 4; i >= 0; i--){
          anum[i] = res[i];
          anumcp[i] = res[i];
    }

  }
  if(b < 0){
    for (i = 0; i < 5; i++){
          temp = bnum[i];
          bnum[i] = bcomp[i];
          bcomp[i] = temp;
    }
  }
}
void add(int num[]){
    int i;
    c = 0;
    for ( i = 0; i < 5; i++){
          res[i] = pro[i] + num[i] + c;
          if (res[i] >= 2){
               c = 1;
          }
```

```
            else{
                c = 0;
            }
            res[i] = res[i]%2;
        }
        for (i = 4; i >= 0; i--){
            pro[i] = res[i];
            printf("%d",pro[i]);
        }
    printf(":");
    for (i = 4; i >= 0; i--){
            printf("%d", anumcp[i]);
        }
}
void arshift(){
    int temp = pro[4], temp2 = pro[0], i;
    for (i = 1; i < 5  ; i++){
      pro[i-1] = pro[i];
    }
    pro[4] = temp;
    for (i = 1; i < 5  ; i++){
        anumcp[i-1] = anumcp[i];
    }
    anumcp[4] = temp2;
    printf("\nAR-SHIFT: ");
    for (i = 4; i >= 0; i--){
        printf("%d",pro[i]);
    }
    printf(":");
    for(i = 4; i >= 0; i--){
        printf("%d", anumcp[i]);
    }
}

void main(){
   int i, q = 0;
   printf("\t\tBOOTH'S MULTIPLICATION ALGORITHM");
   printf("\nEnter two numbers to multiply: ");
   printf("\nBoth must be less than 16");
```

```
//simulating for two numbers each below 16
do{
    printf("\nEnter A: ");
    scanf("%d",&a);
    printf("Enter B: ");
    scanf("%d", &b);
 }while(a >=16 || b >=16);

 printf("\nExpected product = %d", a * b);
 binary();
 printf("\n\nBinary Equivalents are: ");
 printf("\nA = ");
 for (i = 4; i >= 0; i--){
    printf("%d", anum[i]);
 }
 printf("\nB = ");
 for (i = 4; i >= 0; i--){
    printf("%d", bnum[i]);
 }
 printf("\nB'+ 1 = ");
 for (i = 4; i >= 0; i--){
    printf("%d", bcomp[i]);
 }
 printf("\n\n");
 for (i = 0;i < 5; i++){
       if (anum[i] == q){
           printf("\n-->");
           arshift();
           q = anum[i];
       }
       else if(anum[i] == 1 && q == 0){
          printf("\n-->");
          printf("\nSUB B: ");
          add(bcomp);
          arshift();
          q = anum[i];
       }
       else{
          printf("\n-->");
```

```
            printf("\nADD B: ");
            add(bnum);
            arshift();
            q = anum[i];
        }
    }

    printf("\nProduct is = ");
    for (i = 4; i >= 0; i--){
        printf("%d", pro[i]);
    }
    for (i = 4; i >= 0; i--){
        printf("%d", anumcp[i]);
    }
}
```

Output:

```
OUTPUT:-
BOOTH'S MULTIPLICATION ALGORITHM
Enter two numbers to multiply:
Both must be less than 16
Enter A: 10
Enter B: 2
Expected product = 20

Binary Equivalents are:
A = 01010
B = 00010
B'+ 1 = 11110



-->
AR-SHIFT: 00000:00101
-->
SUB B: 11110:00101
AR-SHIFT: 11111:00010
-->
ADD B: 00001:00010
AR-SHIFT: 00000:10001
-->
SUB B: 11110:10001
```

```
AR-SHIFT: 11111:01000
-->
ADD B: 00001:01000
AR-SHIFT: 00000:10100
Product is = 0000010100
```

Conclusion -

Booth's algorithm is a multiplication technique used to multiply two signed binary numbers efficiently. It reduces the number of partial products that must be added together during the multiplication process, leading to faster multiplication operations. The algorithm is especially useful in hardware implementations and digital signal processing applications.

The key idea behind Booth's algorithm is to take advantage of patterns in the binary representation of the multiplier to reduce the number of additions required. It does this by considering pairs of adjacent bits in the multiplier and using them to determine when to add or subtract the multiplicand.