Experiment No. 7
Implement Booth's algorithm using c-programming
Name: Swarup Kakade
Roll Number: 19
Date of Performance:
Date of Submission:

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

Objective -

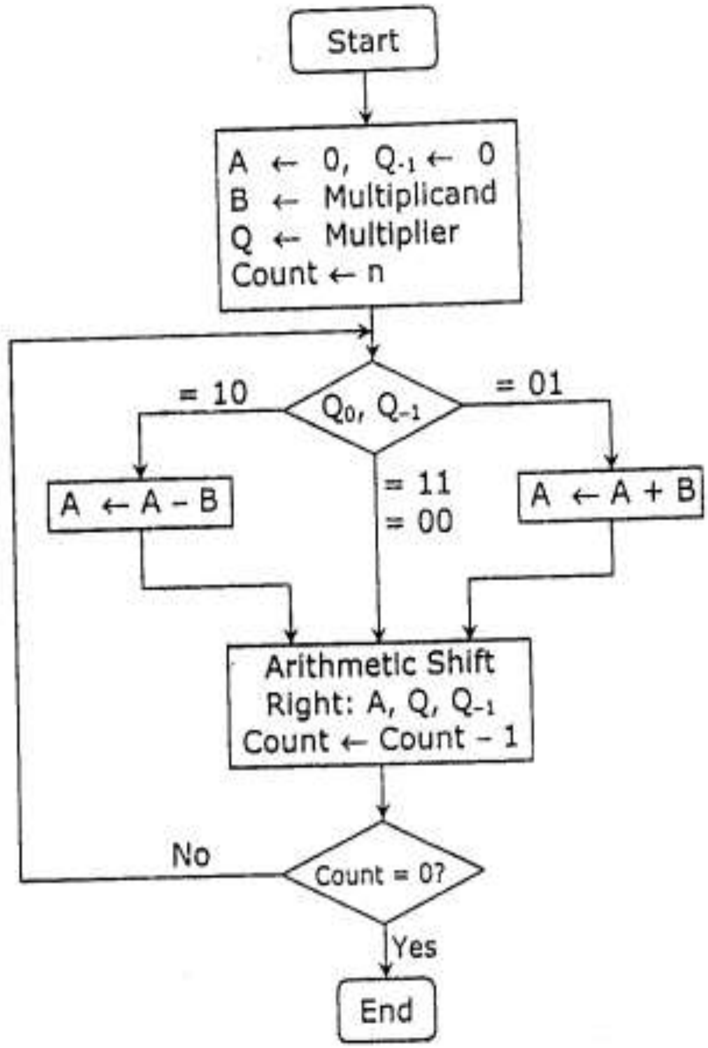
1. To understand the working of Booths algorithm.
2. To understand how to implement Booth's algorithm using c-programming.

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 method for efficiently multiplying two signed binary numbers. It aims to minimize the number of intermediate products that need to be summed during the multiplication, making it a valuable tool in hardware designs and digital signal processing tasks.
The central concept of Booth's algorithm revolves around exploiting patterns within the binary representation of the multiplier to cut down on addition operations. This is achieved by examining adjacent bit pairs in the multiplier and using this information to decide whether to add or subtract the multiplicand at specific points in the multiplication process.