Experiment No. 7
Implement Booth's algorithm using c-programming
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Aim: To implement Booth's algorithm using c-programming.

Objective -

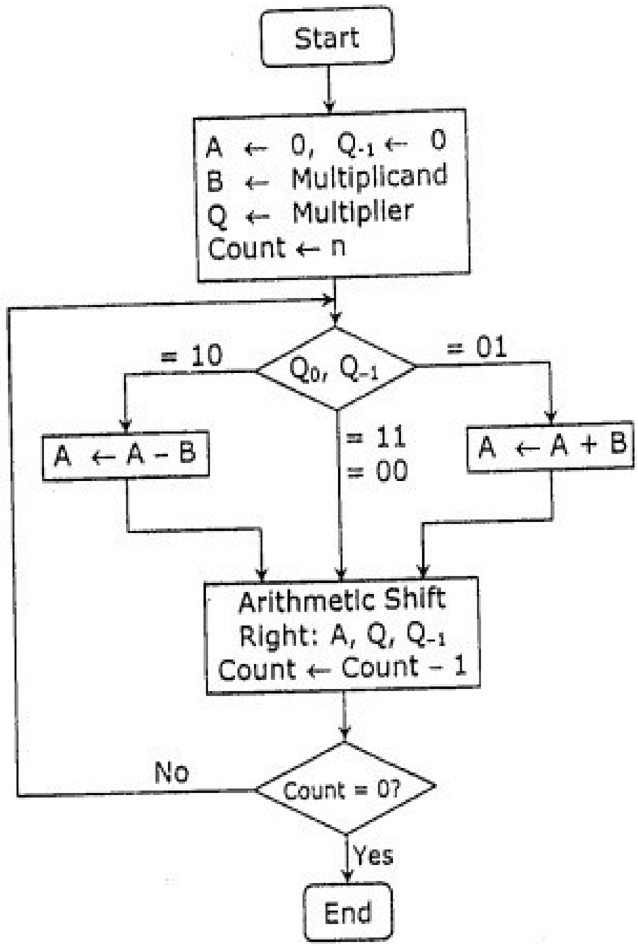
- To understand the working of Booths algorithm.
- To understand how to implement Booth's algorithm using c-programming.

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\tBOO
TH'S
MULTIPLICAT
ION
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 -

This experiment involving Booth's algorithm has underscored its importance in enhancing binary multiplication efficiency. Booth's algorithm effectively reduces the quantity of partial products and minimizes the overall operations needed for multiplication. This not only accelerates computational speed but also trims down hardware intricacy. Booth's algorithm stands as a potent instrument for streamlining multiplication procedures and constitutes a vital concept within digital arithmetic. Our experiment has effectively showcased its realworld applicability in computer system architecture and the design of digital circuits.