Batch: A3 Roll No.:16010121051
Experiment / assignment / tutorial No._____
Grade: AA / AB / BB / BC / CC / CD /DD
Signature of the Staff In-charge with date

TITLE : To study and implement Restoring method of division

AIM : The basis of algorithm is based on paper and pencil approach and the operation involves repetitive shifting with addition and subtraction. So the main aim is to depict the usual process in the form of an algorithm.

Expected OUTCOME of Experiment: (Mention CO /CO's attained here)

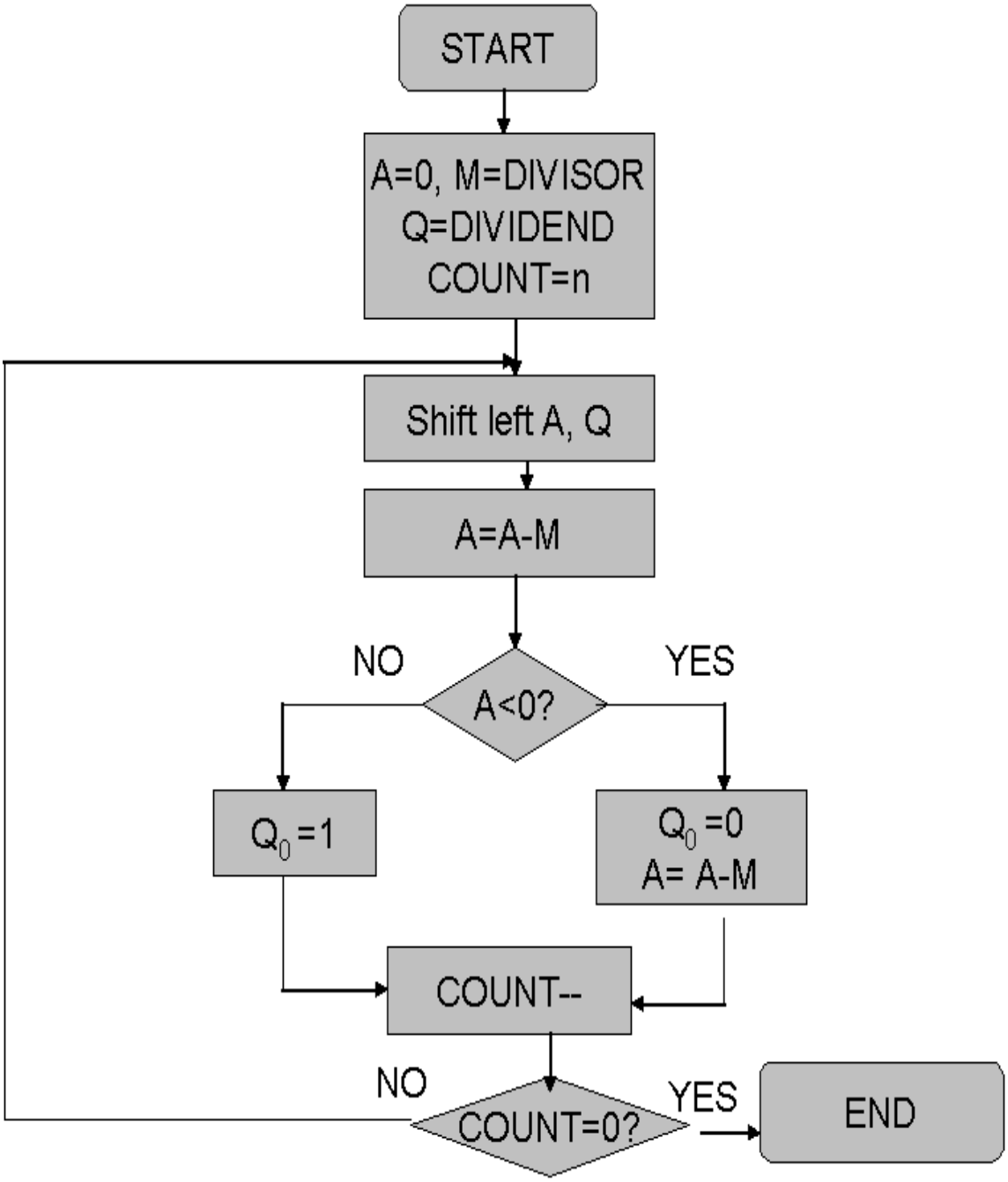
Books/ Journals/ Websites referred:

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization", Fifth Edition, TataMcGraw-Hill.
2. William Stallings, "Computer Organization and Architecture: Designing for Performance", Eighth Edition, Pearson.
3. Dr. M. Usha, T. S. Srikanth, "Computer System Architecture and Organization", First Edition, Wiley-India.

Pre Lab/ Prior Concepts:

The Restoring algorithm works with any combination of positive and negative numbers.

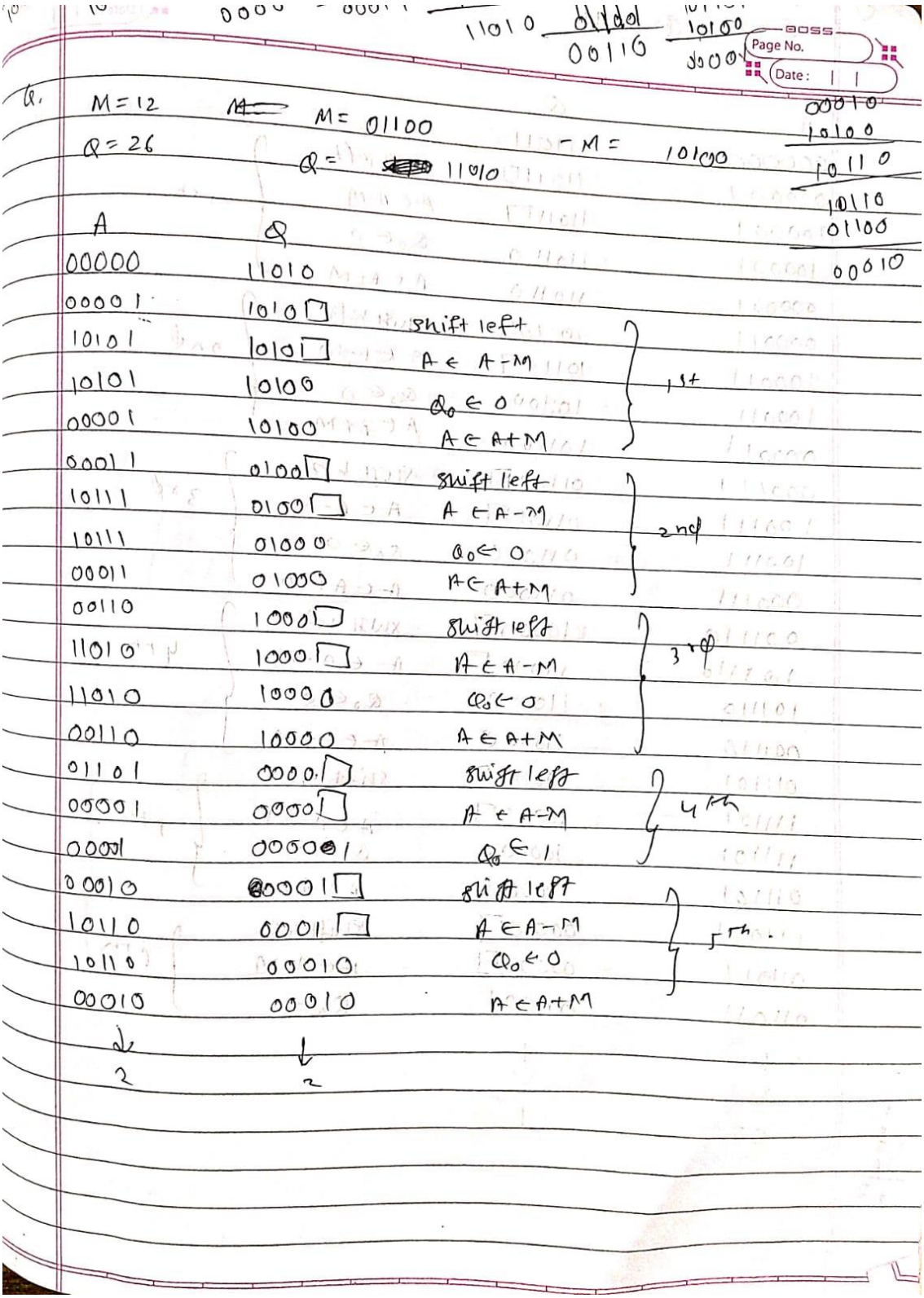
Flowchart for Restoring of Division:

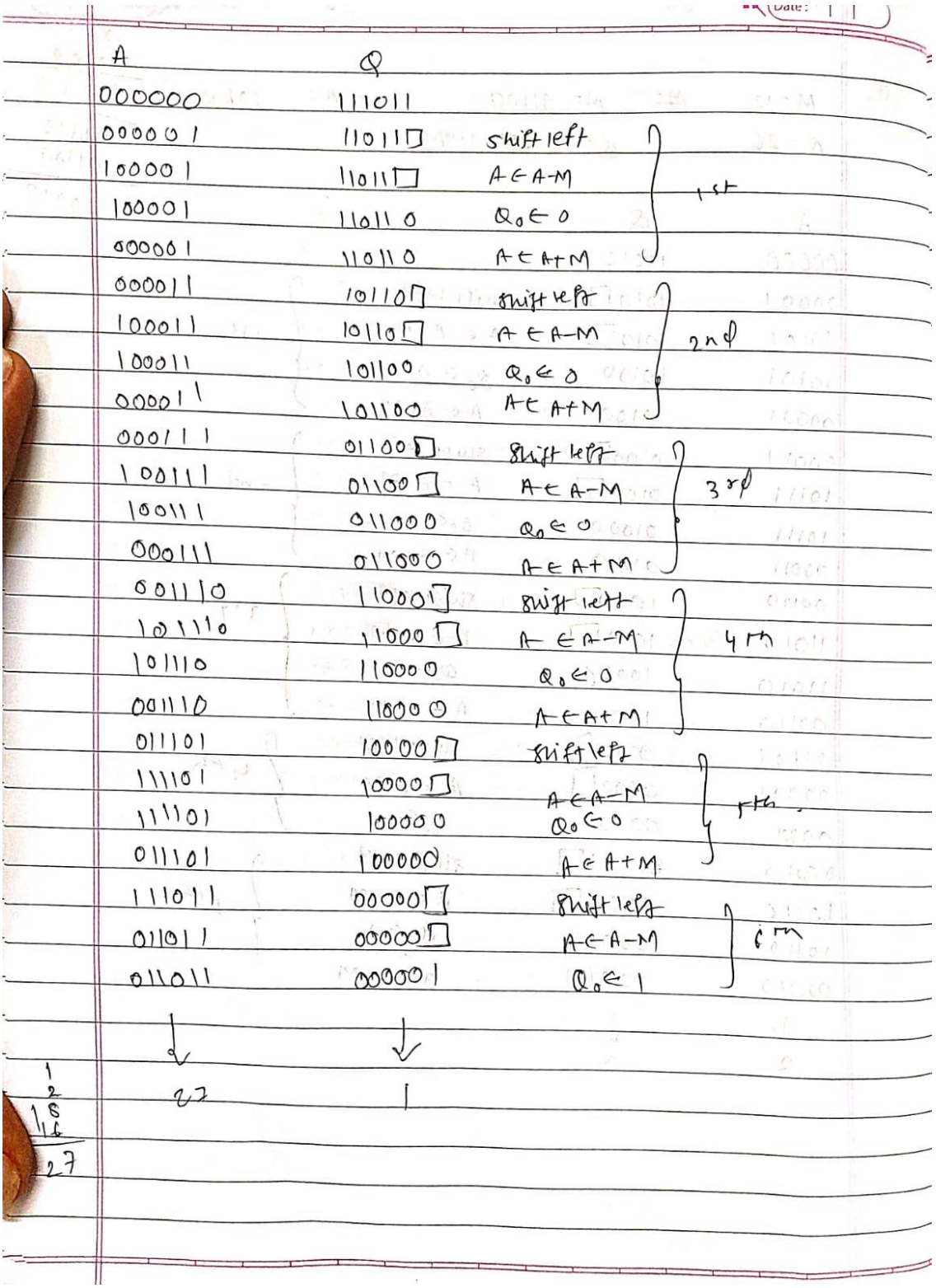


Design Steps:

1. Start
2. Initialize A=0, M=Divisor, Q=Dividend and count=n (no of bits)
3. Left shift A, Q
4. If MSB of A and M are same
5. Then A=A-M
6. Else A=A+M
7. If MSB of previous A and present A are same
8. Q_0=0 & store present A
9. Else Q_0=0 & restore previous A
10. Decrement count.
11. If count=0 go to 11
12. Else go to 3
13. STOP

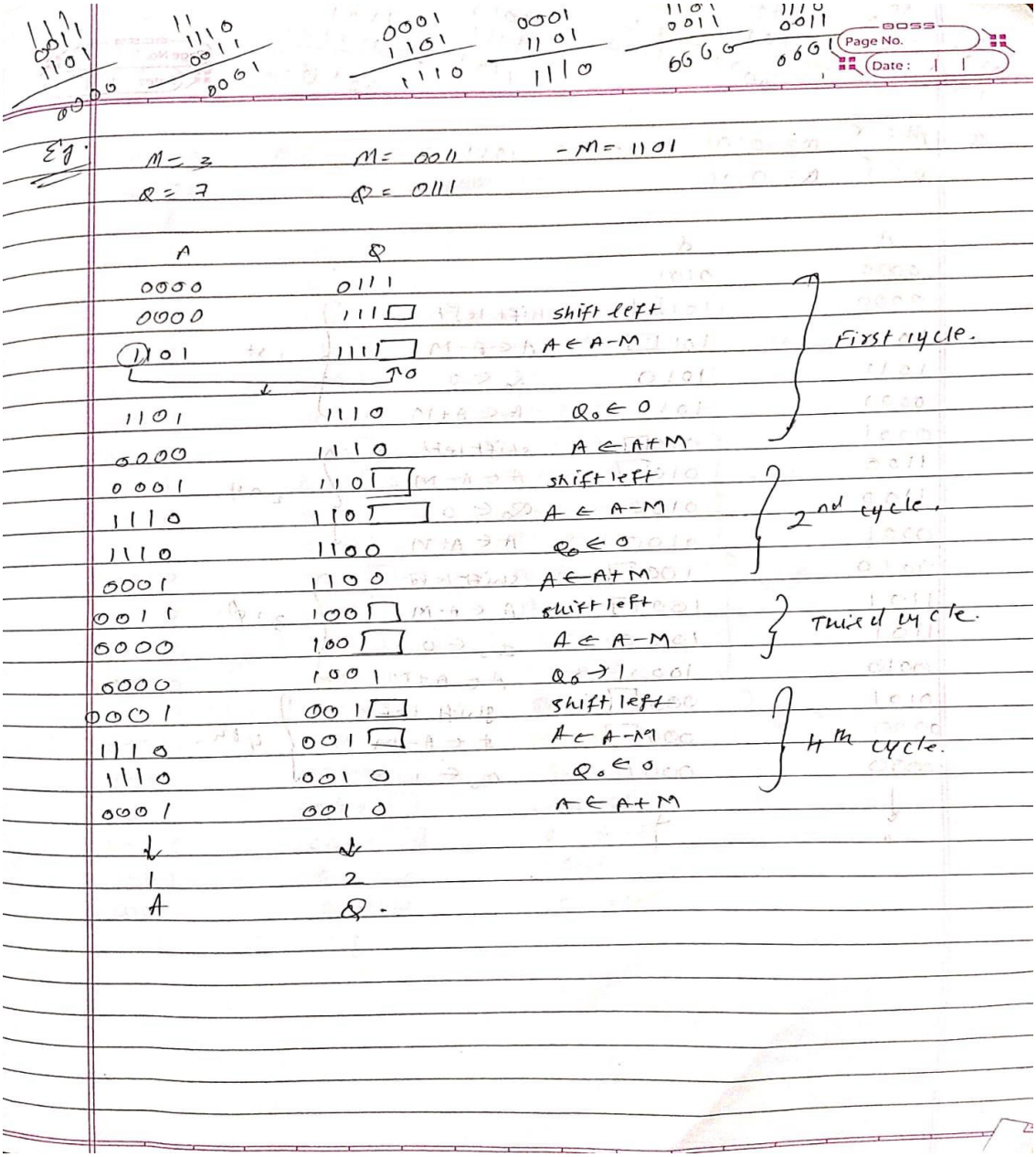
Example:-

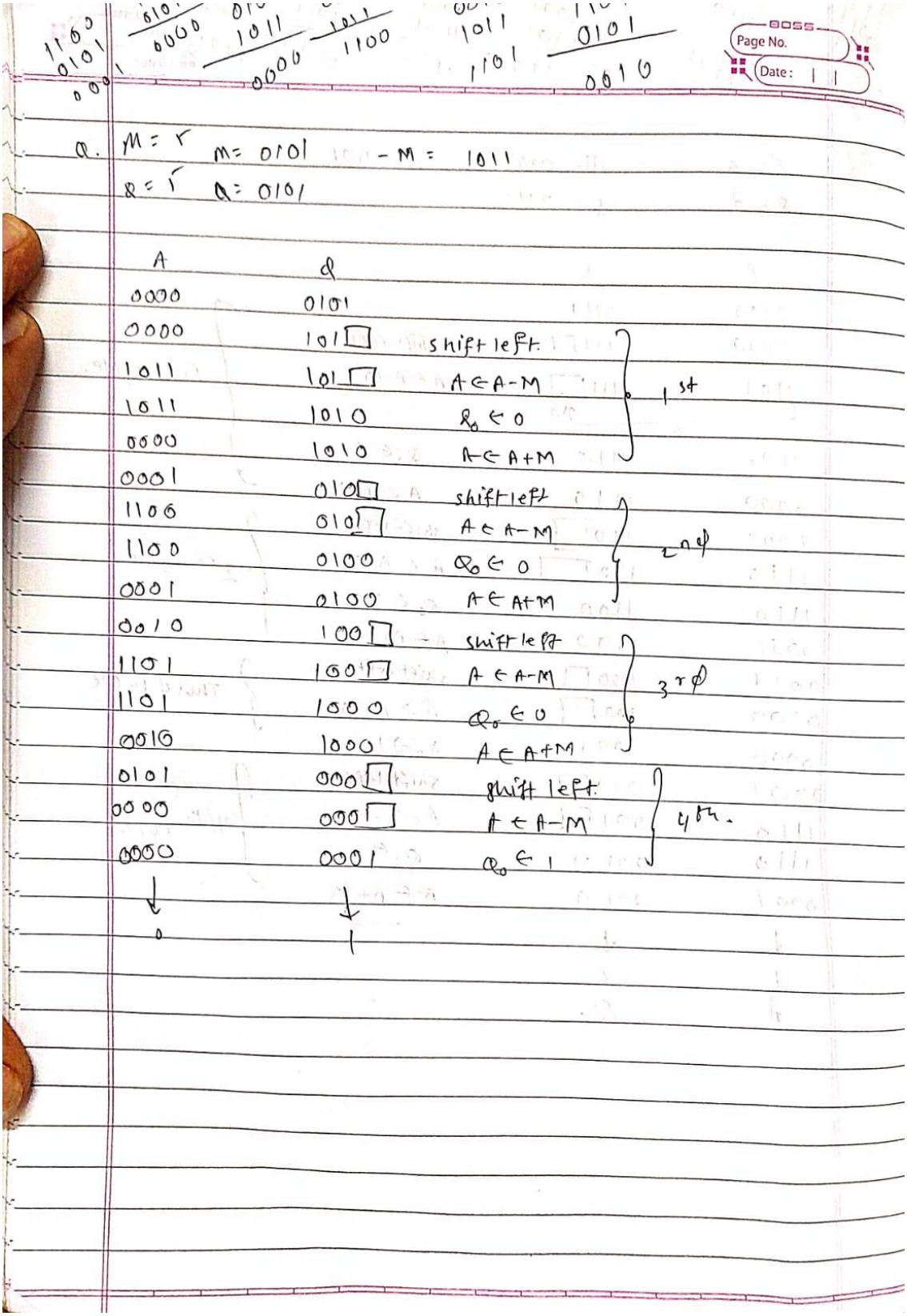

Page No.
Date :
Q. M = 12
Q = 26
M = 01100
-M = 10100
Q = 11010
A
Q
00000 11010
shift left
A ← A-M
Q0 ← 0
A ← A+M
1st
2nd
3rd
4th
5th
00010
10110
01100
00010



A	Q		
000000	111011		
000001	110111	shift left	1st
100001	110111	A ← A-M	
100001	110110	$Q_0 \leftarrow 0$	
000001	110110	A ← A+M	
000011	101101	shift left	2nd
100011	101100	A ← A-M	
100011	101100	$Q_0 \leftarrow 0$	
000011	101100	A ← A+M	
000111	011001	shift left	3rd
100111	011000	A ← A-M	
100111	011000	$Q_0 \leftarrow 0$	
000111	011000	A ← A+M	
001110	110001	shift left	4th
101110	110000	A ← A-M	
101110	110000	$Q_0 \leftarrow 0$	
001110	110000	A ← A+M	
011101	100001	shift left	5th
111101	100000	A ← A-M	
111101	100000	$Q_0 \leftarrow 0$	
011101	100000	A ← A+M	
111011	000001	shift left	6th
011011	000001	A ← A-M	
011011	000001	$Q_0 \leftarrow 1$	
↓	↓		
27	1		

1
2
16
27


Eg:
M = 3
Q = 7
M = 0011
-M = 1101
Q = 0111
A
Q
shift left
A ← A-M
First cycle.
Q0 ← 0
A ← A+M
2nd cycle.
Third cycle.
Q0 → 1
4th cycle.
1
2
A
Q.



Q. M = 5 m = 0101 −M = 1011
Q = 5 Q = 0101

A	Q		
0000	0101		
0000	101□	shift left	1st
1011	101□	A ← A−M	
1011	1010	$Q_0 \leftarrow 0$	
0000	1010	A ← A+M	
0001	010□	shift left	2nd
1106	010□	A ← A−M	
1100	0100	$Q_0 \leftarrow 0$	
0001	0100	A ← A+M	
0010	100□	shift left	3rd
1101	100□	A ← A−M	
1101	1000	$Q_0 \leftarrow 0$	
0016	1000	A ← A+M	
0101	000□	shift left	4th.
0000	000□	A ← A−M	
0000	0001	$Q_0 \leftarrow 1$	
↓	↓		
0	1		

Implementation:

```
/*Program for Restoring Division.*/

#include <stdio.h>

#include <conio.h>

#include <math.h>


int a=0,b=0,c=0,com[5]={1,0,0,0,0},s=0;

int anum[5]={0},anumcp[5] ={0},bnum[5]={0};

int acomp[5]={0},bcomp[5]={0},rem[5]={0},quo[5]={0},res[5]={0};


void binary(){

   a = fabs(a);

   b = fabs(b);

   int r, r2, i, temp;

   for(i = 0; i < 5; i++){

        r = a % 2;

        a = a / 2;

        r2 = b % 2;

        b = b / 2;

        anum[i] = r;

        anumcp[i] = r;
```

```
        bnum[i] = r2;
        if(r2 == 0){
            bcomp[i] = 1;
        }
        if(r == 0){
            acomp[i] =1;
        }
    }
  //part for two's complementing
  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];
```

```
    }
}
void add(int num[]){
    int i;
    c = 0;
    for( i = 0; i < 5; i++){
        res[i] = rem[i]+ num[i] + c;
        if(res[i]>=2){
            c = 1;
        }
        else
            c = 0;
        res[i] = res[i]%2;
    }
    for(i = 4; i>= 0; i--){
        rem[i] = res[i];
        printf("%d",rem[i]);
    }
    printf(":");
    for(i = 4; i>= 0; i--){
        printf("%d",anumcp[i]);
```

```
    }
}
void shl(){//for shift left
    int i;
    for(i = 4; i > 0  ; i--){//shift the remainder
        rem[i] = rem[i-1];
    }
    rem[0] = anumcp[4];
    for(i = 4; i > 0  ; i--){//shift the remtient
        anumcp[i] = anumcp[i-1];
    }
    anumcp[0] = 0;
    printf("\nSHIFT LEFT: ");//display together
    for(i = 4; i>= 0; i--){
        printf("%d",rem[i]);
    }
    printf(":");
    for(i = 4; i>= 0; i--){
        printf("%d",anumcp[i]);
    }
}
```

```
int main(){
   ;
   int i;
   printf("\t\tRESTORING DIVISION ALGORITHM");
   printf("\nEnter two numbers to multiply: ");
   printf("\nBoth must be less than 16");
   //simulating for two numbers each below 16
   do{
         printf("\nEnter Dividened: ");
         scanf("%d",&a);
         printf("Enter Divisor: ");
         scanf("%d",&b);
   }while(a>=16 || b>=16);

   printf("\nExpected Quotient = %d", a/b);
   printf("\nExpected Remainder = %d", a%b);
   if(a*b <0){
         s = 1;
   }
```

```
    binary();
    printf("\n\nUnsigned Binary 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-->");
    //division part
    shl();
    for(i=0;i<5;i++){
        printf("\n-->"); //start with subtraction
        printf("\nSUB B: ");
        add(bcomp);
```

```
        if(rem[4]==1){//simply add for restoring
            printf("\n-->RESTORE");
            printf("\nADD B: ");
            anumcp[0] = 0;
            add(bnum);
        }
        else{
            anumcp[0] = 1;
        }
        if(i<4)
            shl();

    }
    printf("\n----------------------------");
    printf("\nSign of the result = %d",s);
    printf("\nRemainder is = ");
    for(i = 4; i>= 0; i--){
        printf("%d",rem[i]);
    }
    printf("\nQuotient is = ");
    for(i = 4; i>= 0; i--){
```

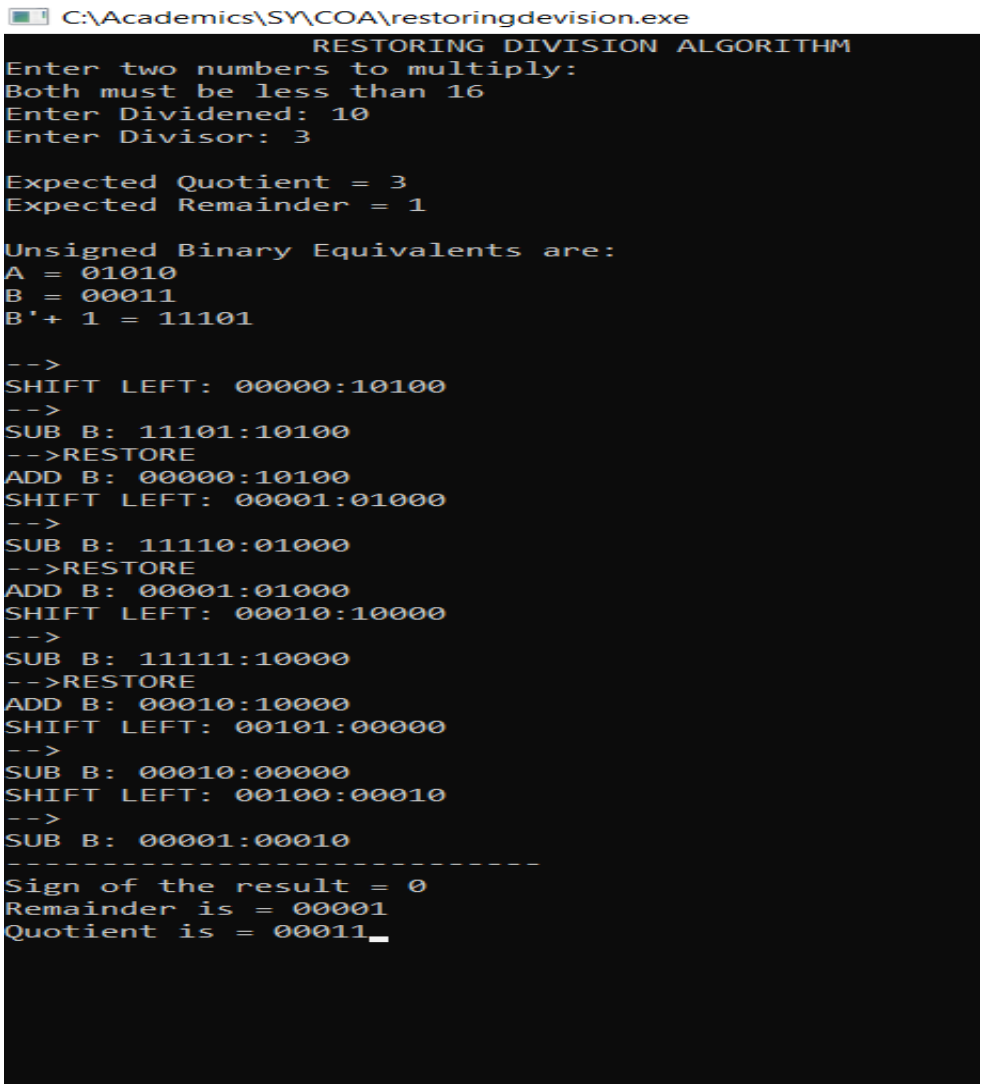
```
        printf("%d",anumcp[i]);

    }

getch();


}
```

Output:



Conclusion:

Booths restoring division was implemented successfully.

Post Lab Descriptive Questions

1. **What are the advantages of restoring division over non restoring division?**

The advantage of using non - restoring arithmetic over the standard restoring division is that a test subtraction is not required; the sign bit determines whether an addition or subtraction is used. The disadvantage, though, is that an extra bit must be maintained in the partial remainder to keep track of the sign.

Date: _____ **Signature of faculty in-charge**