Experiment No. 9
Implement Non-Restoring algorithm using c-programming
Date of Performance: 19/9/24
Date of Submission:

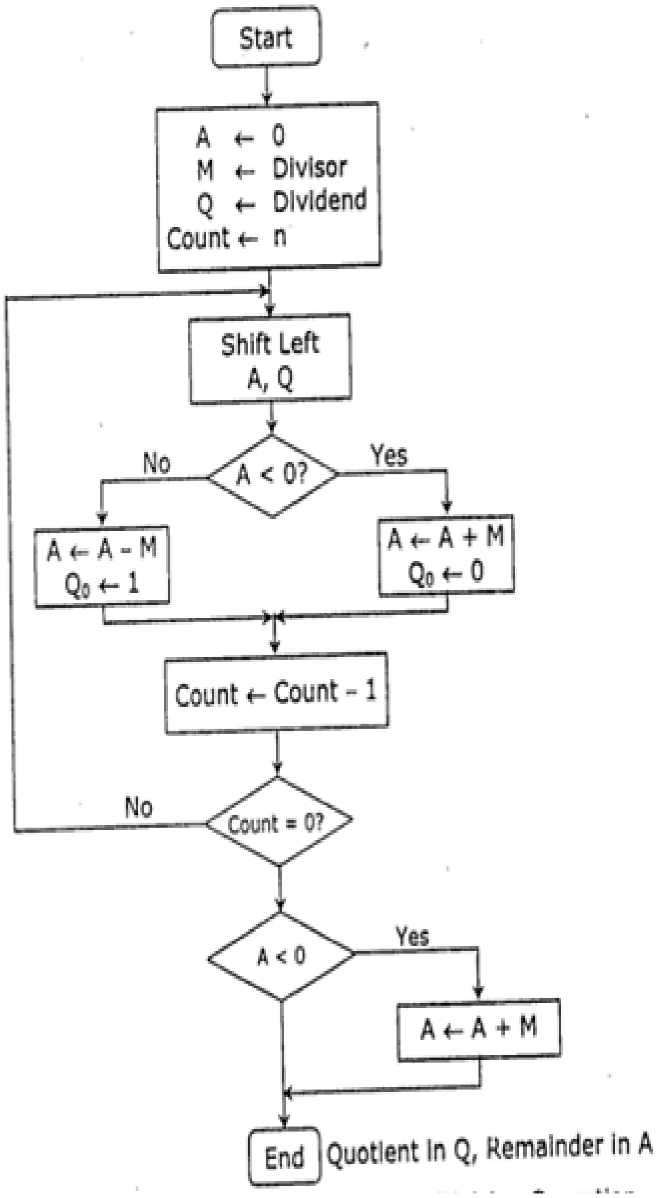
Aim - To implement Non-Restoring division algorithm using c-programming.

Objective -

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

Theory:

In each cycle content of the register, A is first shifted and then the divisor is added or subtracted with the content of register A depending upon the sign of A. In this, there is no need of restoring, but if the remainder is negative then there is a need of restoring the remainder. This is the faster algorithm of division.



Perform 8 ÷ 3 by non-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	1 1 1 0 1		
Set Q_0	1 1 1 1 0	0 0 0 0	
Shift	1 1 1 0 0	0 0 0 □	Second Cycle
Add	0 0 0 1 1		
Set Q_0	1 1 1 1 1	0 0 0 0	
Shift	1 1 1 1 0	0 0 0 □	Third Cycle
Add	0 0 0 1 1		
Set Q_0	0 0 0 0 1	0 0 0 1	
Shift	0 0 0 1 0	0 0 1 □	Fourth Cycle
Subtract	1 1 1 0 1		
Set Q_0	1 1 1 1 1	0 0 1 0 (Quotient)	
Add	1 1 1 1 1		
	0 0 0 1 1		
	0 0 0 1 0 (Remainder)		

Program -

```
#include <stdio.h>

void binaryPrint(int n, int bits) {
    for (int i = bits - 1; i >= 0; i--) {
        printf("%d", (n >> i) & 1);
    }
    printf("\n");
}

int main() {
    int M, Q, A = 0, count;
    int n;

    printf("Enter the divisor (M): ");
    scanf("%d", &M);
    printf("Enter the dividend (Q): ");
    scanf("%d", &Q);
    printf("Enter the number of bits: ");
    scanf("%d", &n);

    count = n;

    printf("\nInitial values:\n");
    printf("A: ");
    binaryPrint(A, n);
    printf("Q: ");
    binaryPrint(Q, n);
    printf("M: ");
    binaryPrint(M, n);
    printf("\n");

    while (count > 0) {
        A = (A << 1) | ((Q >> (n - 1)) & 1);
        Q = Q << 1;

        printf("After left shift:\n");
        printf("A: ");
        binaryPrint(A, n);
```

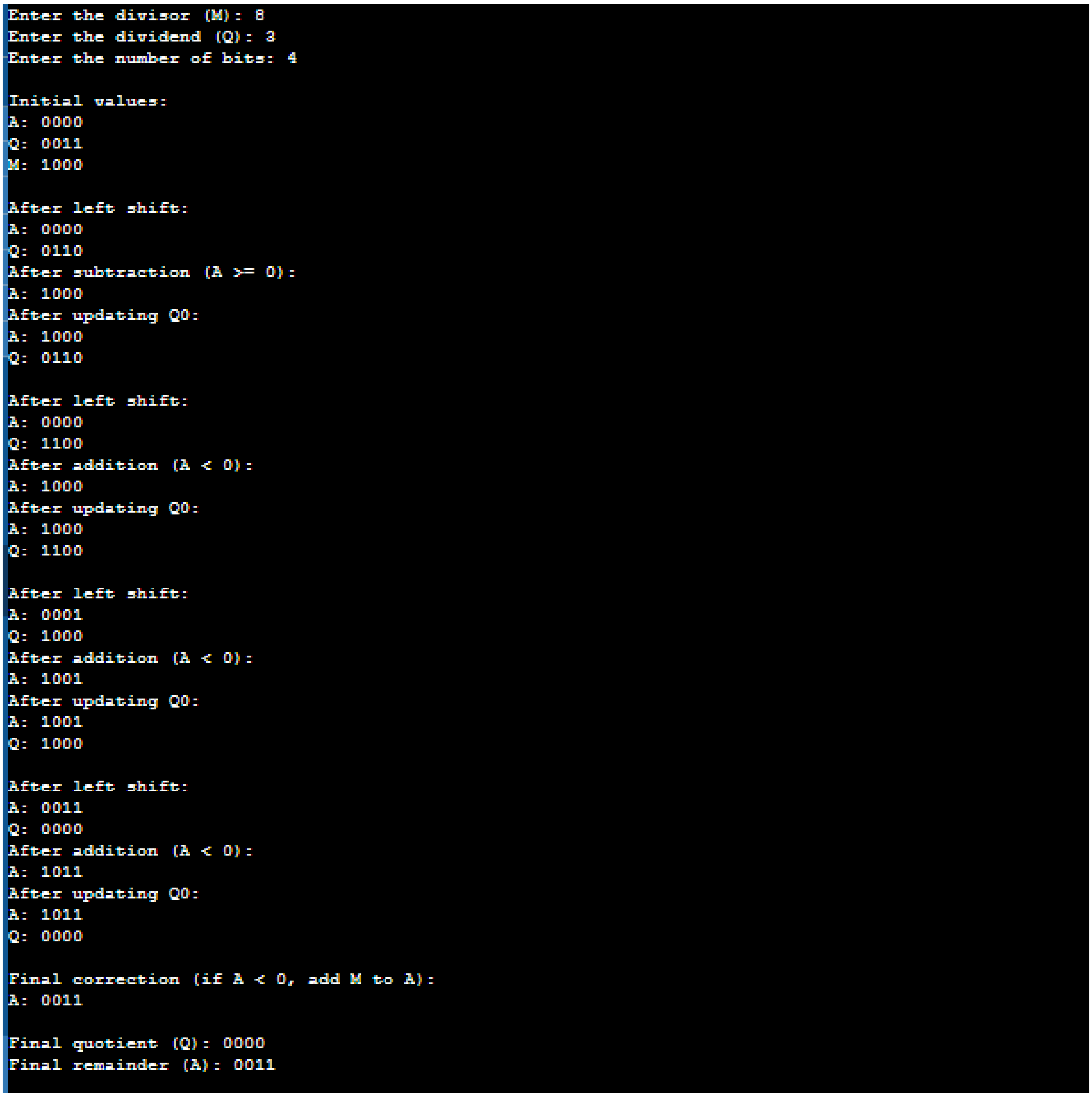
```
        printf("Q: ");
        binaryPrint(Q, n);

        if (A >= 0) {
            A = A - M;
            printf("After subtraction (A >= 0):\n");
        } else {
            A = A + M;
            printf("After addition (A < 0):\n");
        }

        printf("A: ");
        binaryPrint(A, n);

        if (A >= 0) {
            Q = Q | 1;
        } else {
            Q = Q & ~(1);
        }

        printf("After updating Q0:\n");
        printf("A: ");
        binaryPrint(A, n);
        printf("Q: ");
        binaryPrint(Q, n);
        printf("\n");

        count--;
    }

    if (A < 0) {
        A = A + M;
        printf("Final correction (if A < 0, add M to A):\n");
        printf("A: ");
        binaryPrint(A, n);
    }

    printf("\nFinal quotient (Q): ");
    binaryPrint(Q, n);
    printf("Final remainder (A): ");
    binaryPrint(A, n);
```

```
    return 0;
}
```

Output:

```
Enter the divisor (M): 8
Enter the dividend (Q): 3
Enter the number of bits: 4

Initial values:
A: 0000
Q: 0011
M: 1000

After left shift:
A: 0000
Q: 0110
After subtraction (A >= 0):
A: 1000
After updating Q0:
A: 1000
Q: 0110

After left shift:
A: 0000
Q: 1100
After addition (A < 0):
A: 1000
After updating Q0:
A: 1000
Q: 1100

After left shift:
A: 0001
Q: 1000
After addition (A < 0):
A: 1001
After updating Q0:
A: 1001
Q: 1000

After left shift:
A: 0011
Q: 0000
```

```
After addition (A < 0):
A: 1011
After updating Q0:
A: 1011
Q: 0000

Final correction (if A < 0, add M to A):
A: 0011

Final quotient (Q): 0000
Final remainder (A): 0011
```



```
Enter the divisor (M): 8
Enter the dividend (Q): 3
Enter the number of bits: 4

Initial values:
A: 0000
Q: 0011
M: 1000

After left shift:
A: 0000
Q: 0110
After subtraction (A >= 0):
A: 1000
After updating Q0:
A: 1000
Q: 0110

After left shift:
A: 0000
Q: 1100
After addition (A < 0):
A: 1000
After updating Q0:
A: 1000
Q: 1100

After left shift:
A: 0001
Q: 1000
After addition (A < 0):
A: 1001
After updating Q0:
A: 1001
Q: 1000

After left shift:
A: 0011
Q: 0000
After addition (A < 0):
A: 1011
After updating Q0:
A: 1011
Q: 0000

Final correction (if A < 0, add M to A):
A: 0011

Final quotient (Q): 0000
Final remainder (A): 0011
```

Conclusion -

The Non-Restoring Division Algorithm is an efficient method of division as it eliminates the need to restore the previous remainder after every negative result. Instead, a conditional correction is made only at the end if the remainder is negative. In this example, we successfully implemented the algorithm in C programming and verified the correctness of the result with the binary output for each step, demonstrating how the quotient and remainder are calculated.