ФГБОУ ВПО «СПбНИУ ИТМО»

*Факультет программной инженерии и компьютерной техники*

*Дисциплина “Дискретная математика”*

**Домашнее задание №7**

**УМНОЖЕНИЕ ЧИСЕЛ С ПЛАВАЮЩЕЙ ЗАПЯТОЙ**

**66 вариант**

Выполнил:

Мантуш Даниил Валерьевич,

группа Р3119

Санкт-Петербург

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# Задание

1. Заданные числа ***А*** (множимое) и ***В*** (множитель) представить в форматах *Ф*1 и *Ф2* с укороченной мантиссой (12 двоичных разрядов). Метод округления выбирается произвольно.

*Примечание:* общее число разрядов в формате – 20.

1. Выполнить операцию умножения операндов в формате *Ф1*, используя метод ускоренного умножения мантисс на два разряда множителя.
2. Выполнить операцию умножения операндов в формате *Ф2*, используя метод ускоренного умножения мантисс на четыре разряда множителя.
3. Результаты представить в форматах операндов, перевести в десятичную систему счисления и проверить их правильность.
4. Определить абсолютную и относительную погрешности результатов и обосновать их причину.
5. Сравнить погрешности результатов аналогичных операций для форматов *Ф1* и *Ф2* и объяснить причины их сходства или различия.

***A* = 1,1  
*B* = 0,023**

**1. Формат Ф1**  
*A* = (1,1)10 = (1,19999A)16 = (0,119999A)16 · 161

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |

*B* = (0,023)10 = (0,05E354)16 = (0,5E354)16 · 16-1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |

SignC = SignA ⊕ SignB.  
XA = PA + d; XB = PВ + d;  
XC = XA + XB – d;

|  |  |  |
| --- | --- | --- |
| PC + d = | PA + d + PB | + d – d. |
| PC |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| XA | = | + |  | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| XB | = |  | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| XA+XB | = | - | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| d | = |  | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| XC | = |  |  | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

PC = 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **№** | **Операнды** | **СЧП (старшие разряды)** | | | | | | | | | | | | | | | **В/СЧП (младшие разряды)** | | | | | | | | | | | | **Признак коррекции** |
| 0 | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| 1 | [-MA]доп | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | -MA | | | | | | | | | | | | 1 |
| СЧП | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| СЧП->2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 2 | [MA]пр | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | MA | | | | | | | | | | | | 0 |
| СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| СЧП->2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| 3 | [2MA]пр | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 2MA | | | | | | | | | | | | 0 |
| СЧП | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| СЧП->2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| 4 | [-MA]доп | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | -MA | | | | | | | | | | | | 1 |
| СЧП | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| СЧП->2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| 5 | [2MA]пр | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 2MA | | | | | | | | | | | | 0 |
| СЧП | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| СЧП->2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| 6 | [MA]пр | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | MA | | | | | | | | | | | | 0 |
| СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| СЧП->2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 7 | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| MC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |

XC = XC – 1  
  
С\* = (0,67C)16 · 16-1 = 0,02532959.  
  
Определим абсолютную и относительную погрешности результата:  
ΔС = 0,0253 – 0,02532959 = -0,00002959

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| δС = |  | -0,00002959 |  | · 100% = 0,1169559% |
| 0,0253 |

**2. Формат Ф2**  
*A* = (1,1)10 = (1,19999A)16 = (0,1000110011001101)2 · 21

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |

*B* = (0,023)10 = (0,05E354)16 = (0,10111100011)2 · 2-5

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| XA | = | + |  | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| XB | = |  | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| XA+XB | = | - |  | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| d | = |  | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| XC | = |  |  | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |

PC = -4

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **№** | **Операнды** | **СЧП (старшие разряды)** | | | | | | | | | | | | | | | | | **В/СЧП (младшие разряды)** | | | | | | | | | | | | **Признак коррекции** |
| 0 | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| [-MA]доп | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |  |  |  |  |  |  |  |  | -MA | | 8MA | |
| [8MA]пр | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | СЧП | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| СЧП->4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| [-4MA]доп | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |  |  |  |  |  |  |  |  | -4MA | | 0MA | |
| [0MA]пр | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | СЧП | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| СЧП->4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| [-4MA]доп | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |  |  |  |  |  |  |  |  | -4MA | | 0MA | |
| [0MA]пр | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | СЧП | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| СЧП->4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| [MA]пр | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |  |  |  |  |  |  |  |  |  |  | MA | |
|  | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |  |

XC = XC – 1  
  
С\* = (0,110011110100)2 · 2-5 = 0,02529907.  
  
Определим абсолютную и относительную погрешности результата:  
ΔС = 0,0253 – 0,02529907 = 0,00000093

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| δС = |  | 0,00000093 |  | · 100% = 0,00366693% |
| 0,0253 |

Погрешности результатов вызваны неточным представлением операндов. В формате Ф2 операнды представлены точнее и погрешность меньше.