# ПРАВИТЕЛЬСТВО РОССИЙСКОЙ ФЕДЕРАЦИИ
# НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ
# «ВЫСШАЯ ШКОЛА ЭКОНОМИКИ»

Факультет компьютерных наук

Образовательная программа бакалавриата «Программная инженерия»

Пояснительная записка. Микропроект №1

Вариант 24

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## Содержание

## 1   Текст задания

Разработать программу вычисления определителя квадратной матрицы порядка $N = 6$ при условии размещения элементов матрицы в линейном массиве по столбцам.

## 2   Применяемые расчётные методы

Определитель квадратной матрицы $A$ порядка $N = 6$ считается по следующей формуле:

$$\det A = \sum_{\alpha_1, \alpha_2, \ldots, \alpha_6} = (-1)^{N(\alpha_1, \alpha_2, \ldots, \alpha_6)} \cdot a_{1\alpha_1} a_{2\alpha_2} \cdot \ldots \cdot a_{6\alpha_6}$$

где суммирование проводится по всем перестановкам $\alpha_1, \alpha_2, \ldots, \alpha_6$ чисел $1, 2, \ldots, 6$, а $N(\alpha_1, \alpha_2, \ldots, \alpha_6)$ обозначает число инверсий в перестановке $\alpha_1, \alpha_2, \ldots, \alpha_6$ [1].

## 3   Описание используемых переменных

1. **strInputMsg** - сообщение при запуске программы.
2. **strVecElemI** - сообщение при вводе элемента матрицы.
3. **strIncorValue** - сообщение при вводе некорректного значения.
4. **strScanInt** - формат считывания введенного значения функцией $scanf$.
5. **strDetValue** - сообщение при выводе получившегося определителя.
6. **vec_size** - количество элементов в матрице (статично и равно 36).
7. **det** - переменная для хранения получившегося определителя.

## 4   Описание используемых макросов

1. **VInputMacro** - макрос для ввода матрицы по столбцам.
2. **TermMultiply** - макрос для перемножения 6 элементов массива с заданными индексами.
3. **DetAdd** - макрос для добавления результата макроса $TermMultiply$ к переменной.
4. **DetSub** - макрос для вычитания результата макроса $TermMultiply$ из переменной.
5. **VDetMacro** - макрос для вычисления определителя матрицы порядка $N = 6$.

# 5 Область допустимых значений входных параметров

Каждый вводимый элемент матрицы должен принадлежать отрезку $[-50, 50]$.

# 6 Тестовые примеры

## Пример №1

Дана матрица:

$$A = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 2 & 3 & 5 & 7 & 2 & 1 \\ 1 & 6 & 4 & 2 & 1 & 7 \\ 8 & 5 & 4 & 4 & 2 & 1 \\ 1 & 2 & 3 & 4 & 5 & 7 \\ 1 & 2 & 3 & 5 & 5 & 5 \end{pmatrix}$$

Требуется посчитать её определитель. Введем данную матрицу по столбцам в программу (данные приведены в файле $1.txt$ директории $tests$, достаточно скопировать данные файла в окно программы).

```
Input the matrix A by its columns:
A[0] = 1
A[1] = 2
A[2] = 1
A[3] = 8
A[4] = 1
A[5] = 1
A[6] = 2
A[7] = 3
A[8] = 6
A[9] = 5
A[10] = 2
A[11] = 2
A[12] = 3
A[13] = 5
A[14] = 4
A[15] = 4
A[16] = 3
A[17] = 3
A[18] = 4
A[19] = 7
A[20] = 2
A[21] = 4
A[22] = 4
A[23] = 5
A[24] = 5
A[25] = 2
A[26] = 1
A[27] = 2
A[28] = 5
A[29] = 5
A[30] = 6
A[31] = 1
A[32] = 7
A[33] = 1
A[34] = 7
A[35] = 5
det(A) = 474
```

Таким образом, определитель матрицы $A$ равен 474. В корректности ответа можно убедиться на сайте WolframAlpha.

## Пример №2

Дана матрица:

$$A = \begin{pmatrix} -2 & 4 & 1 & 6 & 8 & 2 \\ -7 & -2 & 10 & 2 & 1 & 6 \\ 8 & -4 & 5 & -3 & -6 & 4 \\ 3 & 2 & 5 & 1 & -7 & -5 \\ 7 & 2 & 5 & 6 & 1 & 2 \\ 1 & -2 & 1 & 2 & -8 & 8 \end{pmatrix}$$

Требуется посчитать её определитель. Введем данную матрицу по столбцам в программу (данные приведены в файле $2.txt$ директории $tests$, достаточно скопировать данные файла в окно программы).

```
Input the matrix A by its columns:
A[0] = -2
A[1] = -7
A[2] = 8
A[3] = 3
A[4] = 7
A[5] = 1
A[6] = 4
A[7] = -2
A[8] = -4
A[9] = 2
A[10] = 2
A[11] = -2
A[12] = 1
A[13] = 10
A[14] = 5
A[15] = 5
A[16] = 5
A[17] = 1
A[18] = 6
A[19] = 2
A[20] = -3
A[21] = 1
A[22] = 6
A[23] = 2
A[24] = 8
A[25] = 1
A[26] = -6
A[27] = -7
A[28] = 1
A[29] = -8
A[30] = 2
A[31] = 6
A[32] = 4
A[33] = -5
A[34] = 2
A[35] = 8
det(A) = 159312
```

Таким образом, определитель матрицы $A$ равен 159312. В корректности ответа можно убедиться на сайте WolframAlpha.

## Пример №3. Ввод некорректных данных

При вводе некорректных данных программа выдаст сообщение об ошибке:

```
Input the matrix A by its columns:
A[0] = 10
A[1] = 5
A[2] = -100
Incorrect value = -100 (must be in [-50, 50])
```

# 7 Список используемых источников

1. Кострикин А.И. Введение в алгебру . Часть I. Основы алгебры: Учебник для вузов. — 3-е изд. — М.: ФИЗ-МАТЛИТ, 2004.

# 8 Приложение. Исходный текст программы

**det.asm**

```
format PE console
entry start

include 'win32a.inc'
include 'det_macro.inc'

;------------------------------------------------------------------------
section '.data' data readable writable

        strInputMsg  db 'Input the matrix A by its columns: ', 10, 0
        strVecElemI  db 'A[%d] = ', 0
        strScanInt   db '%d', 0
        strDetValue  db 'det(A) = %d', 10, 0
        strIncorValue db 'Incorrect value = %d (must be in [-50, 50])', 10, 0

        vec_size     dd 36
        det          dd 0
        i            dd ?
        tmp          dd ?
        vec          rd 100

;------------------------------------------------------------------------
section '.code' code readable executable
start:
; 1) matrix input
        push strInputMsg
        call [printf]
        VInputMacro vec, vec_size
; 2) get the matrix determinant
        VDetMacro vec, vec_size, det
; 3) print the determinant
        push [det]
        push strDetValue
        call [printf]

finish:
        call [getch]

        push 0
        call [ExitProcess]

;------------------------------------------------------------------------

section '.idata' import data readable
    library kernel, 'kernel32.dll',\
            msvcrt, 'msvcrt.dll',\
            user32,'USER32.DLL'

include 'api\user32.inc'

include 'api\kernel32.inc'
```

```
    import kernel,\
            ExitProcess, 'ExitProcess'

include 'api\kernel32.inc'
    import msvcrt,\
            printf, 'printf',\
            scanf, 'scanf',\
            getch, '_getch'
```

## det_macro.inc

```
;-------------------------------------------------------------------------
; macro used to input the matrix by its columns
macro VInputMacro vecAddr, len {
VectorInput:
        mov eax, [len]
        cmp eax, 0
        jg  getVector
        getVector:
        xor ecx, ecx              ; ecx = 0
        mov ebx, vecAddr          ; ebx = &vecAddr
getVecLoop:
        mov [tmp], ebx
        cmp ecx, [len]
        jge endInputVector        ; to end of loop

        ; input element
        mov [i], ecx
        push ecx
        push strVecElemI
        call [printf]

        push ebx
        push strScanInt
        call [scanf]

        mov edx, [ebx]
        cmp edx, -50
        jg endVecLoop

IncorrectSize:
        push edx
        push strIncorValue
        call [printf]

        call [getch]

        push 0
        call [ExitProcess]

endVecLoop:
        cmp edx, 50
        jg IncorrectSize

        add esp, 8
```

```asm
        mov ecx, [i]
        inc ecx
        mov ebx, [tmp]
        add ebx, 4
        jmp getVecLoop
endInputVector:
}


;--------------------------------------------------------------------------
; macro used to multiply 6 vector items with given indices
macro TermMultiply vec, i1, i2, i3, i4, i5, i6 {
        mov eax, [vec + 4*i1]
        imul eax, [vec + 4*i2]
        imul eax, [vec + 4*i3]
        imul eax, [vec + 4*i4]
        imul eax, [vec + 4*i5]
        imul eax, [vec + 4*i6]
}


;--------------------------------------  ----------------------------------
; macro used to add multiplication product to given variable
macro DetAdd vec, det, i1, i2, i3, i4, i5, i6 {
        TermMultiply vec, i1, i2, i3, i4, i5, i6
        add [det], eax
}


;--------------------------------------------------------------------------
; macro used to subtract multiplication product from given variable
macro DetSub vec, det, i1, i2, i3, i4, i5, i6 {
        TermMultiply vec, i1, i2, i3, i4, i5, i6
        sub [det], eax
}


;--------------------------------------------------------------------------
; macro used to calculate the matrix determinant
macro VDetMacro vecAddr, len, result {
        xor ecx, ecx            ; ecx = 0
        mov ebx, vecAddr        ; ebx = &vecAddr

        DetAdd vec, det, 0, 7, 14, 21, 28, 35
        DetSub vec, det, 0, 7, 14, 21, 29, 34
        DetSub vec, det, 0, 7, 14, 22, 27, 35
        DetAdd vec, det, 0, 7, 14, 22, 29, 33
        DetAdd vec, det, 0, 7, 14, 23, 27, 34
        DetSub vec, det, 0, 7, 14, 23, 28, 33
        DetSub vec, det, 0, 7, 15, 20, 28, 35
        DetAdd vec, det, 0, 7, 15, 20, 29, 34
        DetAdd vec, det, 0, 7, 15, 22, 26, 35
        DetSub vec, det, 0, 7, 15, 22, 29, 32
        DetSub vec, det, 0, 7, 15, 23, 26, 34
        DetAdd vec, det, 0, 7, 15, 23, 28, 32
        DetAdd vec, det, 0, 7, 16, 20, 27, 35
        DetSub vec, det, 0, 7, 16, 20, 29, 33
        DetSub vec, det, 0, 7, 16, 21, 26, 35
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DetAdd vec, det, 0, 7, 16, 21, 29, 32
DetAdd vec, det, 0, 7, 16, 23, 26, 33
DetSub vec, det, 0, 7, 16, 23, 27, 32
DetSub vec, det, 0, 7, 17, 20, 27, 34
DetAdd vec, det, 0, 7, 17, 20, 28, 33
DetAdd vec, det, 0, 7, 17, 21, 26, 34
DetSub vec, det, 0, 7, 17, 21, 28, 32
DetSub vec, det, 0, 7, 17, 22, 26, 33
DetAdd vec, det, 0, 7, 17, 22, 27, 32
DetSub vec, det, 0, 8, 13, 21, 28, 35
DetAdd vec, det, 0, 8, 13, 21, 29, 34
DetAdd vec, det, 0, 8, 13, 22, 27, 35
DetSub vec, det, 0, 8, 13, 22, 29, 33
DetSub vec, det, 0, 8, 13, 23, 27, 34
DetAdd vec, det, 0, 8, 13, 23, 28, 33
DetAdd vec, det, 0, 8, 15, 19, 28, 35
DetSub vec, det, 0, 8, 15, 19, 29, 34
DetSub vec, det, 0, 8, 15, 22, 25, 35
DetAdd vec, det, 0, 8, 15, 22, 29, 31
DetAdd vec, det, 0, 8, 15, 23, 25, 34
DetSub vec, det, 0, 8, 15, 23, 28, 31
DetSub vec, det, 0, 8, 16, 19, 27, 35
DetAdd vec, det, 0, 8, 16, 19, 29, 33
DetAdd vec, det, 0, 8, 16, 21, 25, 35
DetSub vec, det, 0, 8, 16, 21, 29, 31
DetSub vec, det, 0, 8, 16, 23, 25, 33
DetAdd vec, det, 0, 8, 16, 23, 27, 31
DetAdd vec, det, 0, 8, 17, 19, 27, 34
DetSub vec, det, 0, 8, 17, 19, 28, 33
DetSub vec, det, 0, 8, 17, 21, 25, 34
DetAdd vec, det, 0, 8, 17, 21, 28, 31
DetAdd vec, det, 0, 8, 17, 22, 25, 33
DetSub vec, det, 0, 8, 17, 22, 27, 31
DetAdd vec, det, 0, 9, 13, 20, 28, 35
DetSub vec, det, 0, 9, 13, 20, 29, 34
DetSub vec, det, 0, 9, 13, 22, 26, 35
DetAdd vec, det, 0, 9, 13, 22, 29, 32
DetAdd vec, det, 0, 9, 13, 23, 26, 34
DetSub vec, det, 0, 9, 13, 23, 28, 32
DetSub vec, det, 0, 9, 14, 19, 28, 35
DetAdd vec, det, 0, 9, 14, 19, 29, 34
DetAdd vec, det, 0, 9, 14, 22, 25, 35
DetSub vec, det, 0, 9, 14, 22, 29, 31
DetSub vec, det, 0, 9, 14, 23, 25, 34
DetAdd vec, det, 0, 9, 14, 23, 28, 31
DetAdd vec, det, 0, 9, 16, 19, 26, 35
DetSub vec, det, 0, 9, 16, 19, 29, 32
DetSub vec, det, 0, 9, 16, 20, 25, 35
DetAdd vec, det, 0, 9, 16, 20, 29, 31
DetAdd vec, det, 0, 9, 16, 23, 25, 32
DetSub vec, det, 0, 9, 16, 23, 26, 31
DetSub vec, det, 0, 9, 17, 19, 26, 34
DetAdd vec, det, 0, 9, 17, 19, 28, 32
DetAdd vec, det, 0, 9, 17, 20, 25, 34
DetSub vec, det, 0, 9, 17, 20, 28, 31
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DetSub vec, det, 0, 9, 17, 22, 25, 32
DetAdd vec, det, 0, 9, 17, 22, 26, 31
DetSub vec, det, 0, 10, 13, 20, 27, 35
DetAdd vec, det, 0, 10, 13, 20, 29, 33
DetAdd vec, det, 0, 10, 13, 21, 26, 35
DetSub vec, det, 0, 10, 13, 21, 29, 32
DetSub vec, det, 0, 10, 13, 23, 26, 33
DetAdd vec, det, 0, 10, 13, 23, 27, 32
DetAdd vec, det, 0, 10, 14, 19, 27, 35
DetSub vec, det, 0, 10, 14, 19, 29, 33
DetSub vec, det, 0, 10, 14, 21, 25, 35
DetAdd vec, det, 0, 10, 14, 21, 29, 31
DetAdd vec, det, 0, 10, 14, 23, 25, 33
DetSub vec, det, 0, 10, 14, 23, 27, 31
DetSub vec, det, 0, 10, 15, 19, 26, 35
DetAdd vec, det, 0, 10, 15, 19, 29, 32
DetAdd vec, det, 0, 10, 15, 20, 25, 35
DetSub vec, det, 0, 10, 15, 20, 29, 31
DetSub vec, det, 0, 10, 15, 23, 25, 32
DetAdd vec, det, 0, 10, 15, 23, 26, 31
DetAdd vec, det, 0, 10, 17, 19, 26, 33
DetSub vec, det, 0, 10, 17, 19, 27, 32
DetSub vec, det, 0, 10, 17, 20, 25, 33
DetAdd vec, det, 0, 10, 17, 20, 27, 31
DetAdd vec, det, 0, 10, 17, 21, 25, 32
DetSub vec, det, 0, 10, 17, 21, 26, 31
DetAdd vec, det, 0, 11, 13, 20, 27, 34
DetSub vec, det, 0, 11, 13, 20, 28, 33
DetSub vec, det, 0, 11, 13, 21, 26, 34
DetAdd vec, det, 0, 11, 13, 21, 28, 32
DetAdd vec, det, 0, 11, 13, 22, 26, 33
DetSub vec, det, 0, 11, 13, 22, 27, 32
DetSub vec, det, 0, 11, 14, 19, 27, 34
DetAdd vec, det, 0, 11, 14, 19, 28, 33
DetAdd vec, det, 0, 11, 14, 21, 25, 34
DetSub vec, det, 0, 11, 14, 21, 28, 31
DetSub vec, det, 0, 11, 14, 22, 25, 33
DetAdd vec, det, 0, 11, 14, 22, 27, 31
DetAdd vec, det, 0, 11, 15, 19, 26, 34
DetSub vec, det, 0, 11, 15, 19, 28, 32
DetSub vec, det, 0, 11, 15, 20, 25, 34
DetAdd vec, det, 0, 11, 15, 20, 28, 31
DetAdd vec, det, 0, 11, 15, 22, 25, 32
DetSub vec, det, 0, 11, 15, 22, 26, 31
DetSub vec, det, 0, 11, 16, 19, 26, 33
DetAdd vec, det, 0, 11, 16, 19, 27, 32
DetAdd vec, det, 0, 11, 16, 20, 25, 33
DetSub vec, det, 0, 11, 16, 20, 27, 31
DetSub vec, det, 0, 11, 16, 21, 25, 32
DetAdd vec, det, 0, 11, 16, 21, 26, 31
DetSub vec, det, 1, 6, 14, 21, 28, 35
DetAdd vec, det, 1, 6, 14, 21, 29, 34
DetAdd vec, det, 1, 6, 14, 22, 27, 35
DetSub vec, det, 1, 6, 14, 22, 29, 33
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DetAdd vec, det, 1, 6, 14, 23, 28, 33
DetAdd vec, det, 1, 6, 15, 20, 28, 35
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DetSub vec, det, 1, 8, 12, 23, 28, 33
DetSub vec, det, 1, 8, 15, 18, 28, 35
DetAdd vec, det, 1, 8, 15, 18, 29, 34
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DetSub vec, det, 1, 8, 15, 22, 29, 30
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DetSub vec, det, 1, 9, 14, 18, 29, 34
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DetSub vec, det, 1, 9, 17, 22, 26, 30
DetAdd vec, det, 1, 10, 12, 20, 27, 35
DetSub vec, det, 1, 10, 12, 20, 29, 33
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DetAdd vec, det, 1, 10, 12, 21, 29, 32
DetAdd vec, det, 1, 10, 12, 23, 26, 33
DetSub vec, det, 1, 10, 12, 23, 27, 32
DetSub vec, det, 1, 10, 14, 18, 27, 35
DetAdd vec, det, 1, 10, 14, 18, 29, 33
DetAdd vec, det, 1, 10, 14, 21, 24, 35
DetSub vec, det, 1, 10, 14, 21, 29, 30
DetSub vec, det, 1, 10, 14, 23, 24, 33
DetAdd vec, det, 1, 10, 14, 23, 27, 30
DetAdd vec, det, 1, 10, 15, 18, 26, 35
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DetAdd vec, det, 1, 10, 15, 20, 29, 30
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DetAdd vec, det, 1, 10, 17, 18, 27, 32
DetAdd vec, det, 1, 10, 17, 20, 24, 33
DetSub vec, det, 1, 10, 17, 20, 27, 30
DetSub vec, det, 1, 10, 17, 21, 24, 32
DetAdd vec, det, 1, 10, 17, 21, 26, 30
DetSub vec, det, 1, 11, 12, 20, 27, 34
DetAdd vec, det, 1, 11, 12, 20, 28, 33
DetAdd vec, det, 1, 11, 12, 21, 26, 34
DetSub vec, det, 1, 11, 12, 21, 28, 32
DetSub vec, det, 1, 11, 12, 22, 26, 33
DetAdd vec, det, 1, 11, 12, 22, 27, 32
DetAdd vec, det, 1, 11, 14, 18, 27, 34
DetSub vec, det, 1, 11, 14, 18, 28, 33
DetSub vec, det, 1, 11, 14, 21, 24, 34
DetAdd vec, det, 1, 11, 14, 21, 28, 30
DetAdd vec, det, 1, 11, 14, 22, 24, 33
DetSub vec, det, 1, 11, 14, 22, 27, 30
DetSub vec, det, 1, 11, 15, 18, 26, 34
DetAdd vec, det, 1, 11, 15, 18, 28, 32
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DetSub vec, det, 1, 11, 15, 20, 28, 30
DetSub vec, det, 1, 11, 15, 22, 24, 32
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