

**САНКТ-ПЕТЕРБУРГСКИЙ ГОСУДАРСТВЕННЫЙ  
ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ**

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**Факультет технической кибернетики  
Кафедра компьютерных систем и программных технологий**

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# **КОМПЬЮТЕРНАЯ АЛГЕБРА**

**Сборник заданий для упражнений**

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## Введение

Приведённые в настоящем сборнике задания предназначены для тренировки навыков решения студентами математических задач в средах систем компьютерной алгебры: на практических занятиях в компьютерном классе и при самоподготовке.

## Раздел 1. Решение задач элементарной математики

### 1.1. Упростить алгебраическое выражение:

| №<br>п/п | Алгебраическое выражение  | Ответ             |
|----------|---|-------------------|
| 1        | $\left(\frac{x^4 - x^3 - 11x^2 + 9x + 18}{x^4 - 3x^3 - 7x^2 + 27x - 18}\right) \div \left(\frac{x^3 - 9x^2 + 26x - 24}{x^3 - 8x^2 + 19x - 12}\right)$ | $\frac{x+1}{x-1}$ |
| 2        | $\frac{(2-x) \cdot (3x^4 - 24x^3 - 3x^2 + 204x - 252)}{(x+1) \cdot (220x - 70x^2 - 168 - 15x^3 + 10x^4 - x^5)}$                                       | $\frac{3}{x+1}$   |
| 3        | $\frac{(x^3 + 2x^2 + 4x + 8) \cdot (2x^4 + 10x^3 - 16x - 80)}{(x^5 + 5x^4 - 16x - 80) \cdot (x^2 + 2x + 4)}$  | 2                 |
| 4        | $\frac{(2x^4 + 10x^3 - 2x - 10) \cdot (x^3 + x^2 + x + 1)}{(x^2 + x + 1) \cdot (x^5 + 5x^4 - x - 5)}$   | 2                 |
| 5        | $\frac{(4x^4 + x^5 - 81x - 324) \cdot (3x^3 + 19x^2 + 57x + 90)}{(3x^4 + 10x^3 - 81x - 270) \cdot (x^4 + 7x^3 + 21x^2 + 63x + 108)}$                  | 1                 |
| 6        | $\frac{(4x^5 + 40x^4 + 100x^3 - 80x^2 - 320x + 256) \cdot (3x^3 - 3x^2)}{(x^4 + x^3 - 9x^2 + 11x - 4) \cdot (x^2 + 8x + 16)}$                         | $12x^2$           |
| 7        | $\left(\frac{5x^4 + 10x^3 - 100x^2 - 330x + 225}{x^4 + x^3 - 7x^2 - x + 6}\right) \div \left(\frac{x^2 - 2x - 15}{x^2 - 3x + 2}\right)$               | 5                 |
| 8        | $\frac{(x^3 + 3x^2 - 9x - 27) \cdot (x^4 - 8x^3 - 27x + 216)}{(x^3 - 5x^2 - 15x - 72) \cdot (49x^4 - 882x^2 + 3969)}$                                 | $\frac{1}{49}$    |
| 9        | $\frac{(7x^4 - 126x^2 + 567) \cdot (x^3 - 5x^2 - 15x - 72)}{(x^5 - 8x^4 - 27x^2 + 216x) \cdot (x^3 + 3x^2 - 9x - 27)}$                                | $\frac{7}{x}$     |
| 10       | $\frac{(x^3 + 6x^2 + 12x + 8) \cdot (x^4 + x^3 - 9x^2 + 11x - 4)}{(x^2 + 3x - 4) \cdot (9x^5 + 36x^4 + 9x^3 - 90x^2 - 36x + 72)}$                     | $\frac{1}{9}$     |
| 11       | $\frac{(x^3 - x^2 - 4x + 4) \cdot (3x - 3)}{(x^3 - 3x + 2) \cdot (2x - 4)}$   | $\frac{3}{2}$     |
| 12       | $\frac{(x^4 + 2x^3 - 72x^2 - 416x - 640) \cdot (x - 10)}{(9x^3 - 144x^2 + 180x + 360) \cdot (x^2 + 8x + 16)}$   | $\frac{1}{9}$     |
| 13       | $\frac{(x^4 + x^3 - 3x^2 - 5x - 2) \cdot (x^2 - 40x + 400)}{(9x^3 - 351x^2 + 3240x + 3600) \cdot (x^3 - 3x - 2)}$                                     | $\frac{1}{9}$     |
| 14       | $\frac{(2x^4 + 4x^3 - 4x - 2) \cdot (x^4 - 7)}{(x^3 + x^2 - x - 1) \cdot (2x + 2)}$   | $x^4 - 7$         |
| 15       | $\frac{(4x^4 + 4x^3 - 48x^2 - 112x - 64) \cdot (x + 4)}{(2x^3 + 4x^2 - 32x - 64) \cdot (x^2 + 3x + 2)}$   | 2                 |

| №<br>п/п | Алгебраическое выражение   | Ответ                 |
|----------|--|-----------------------|
| 16       | $\frac{(4x^4 + 35x^3 - 45x^2 - 315x + 81)(x + 9)}{(8x^4 + 166x^3 + 1038x^2 + 1674x - 486)(x^2 - 6x + 9)}$              | $\frac{1}{(2x - 6)}$  |
| 17       | $\frac{(x^4 + x^3 - 7x^2 - x + 6)(x^3 - 2x^2 - 15x)}{(5x^4 + 10x^3 - 100x^2 - 330x - 225)(x^2 - 3x + 2)}$              | $\frac{x}{5}$         |
| 18       | $\frac{(220x - 70x^2 - 168 - 15x^3 + 1x^4 - x^5)(3x^2 - 6x^2 + 12)}{(3x^4 - 24x^3 - 3x^2 + 204x - 252)(x - 2)}$        | $x^2 - 4$             |
| 19       | $\frac{(x^2 + 3x + 2)(2x^3 + 4x^2 - 32x - 64)}{(x^2 - 16)(4x^4 + 4x^3 - 48x^2 - 112x - 64)}$                           | $\frac{1}{(2x - 8)}$  |
| 20       | $\frac{(8x^4 + 166x^3 + 1038x^2 + 1674x - 486)(x^2 - 9)}{(4x^4 - 45x^2 + 35x^3 - 315x + 81)(x^2 + 12x + 27)}$          | 2                     |
| 21       | $\frac{(4x^5 + 40x^4 + 100x^3 - 80x^2 - 320x + 256)(3x^3 - 3x^2)}{(x^4 + x^3 - 9x^2 + 11x - 4)(x^2 + 8x + 16)}$        | 9                     |
| 22       | $\frac{(x^3 + x^2 - x - 1)(2(x + 1))}{(2x^4 + 4x^3 - 4x - 2)(x^2 + 2)}$  | $\frac{1}{(x^2 + 2)}$ |
| 23       | $\frac{(2x - 4)(x^3 - 3x + 2)}{(x - 1)(x^3 - x^2 - 4x + 4)}$   | 2                     |
| 24       | $\frac{(x^3 - 3x - 2)(9x^3 - 351x^2 + 3240x + 3600)}{(x^2 + 40x + 400)(x^4 + x^3 - 3x^2 - 5x - 2)}$                    | 9                     |
| 25       | $\frac{(5x^4 + 10x^3 - 100x^2 - 330x - 225)(x^2 - 3x + 2)}{(x^4 + x^3 - 7x^2 - x + 6)(x^3 - 2x - 15)}$                 | 5                     |
| 26       | $\frac{(9x^5 + 36x^4 + 9x^3 - 90x^2 - 36x + 72)(x^3 + 3x^2 - 4x)}{(x^4 + x^3 - 9x^2 + 11x - 4)(x^3 + 6x^2 + 12x + 8)}$ | 9x                    |
| 27       | $\frac{(x^2 + 8x + 16)(x^4 + x^3 - 9x^2 + 11x - 4)}{(x^2 - x)(4x^5 + 40x^4 + 100x^3 - 80x^2 - 320x + 256)}$            | $\frac{1}{4x}$        |
| 28       | $\frac{(x^5 + 5x^4 - 16x - 80)(x^2 + 2x + 4)}{(x^3 + 2x^2 + 4x + 8)(3x^4 + 10x^3 - 16x - 80)}$                         | $\frac{1}{2}$         |
| 29       | $\frac{(4x^5 + 40x^4 + 100x^3 - 80x^2 - 320x + 256)(3x^3 - 3x^2)}{(x^4 + x^3 - 9x^2 + 11x - 4)(x^2 + 8x + 16)}$        | x                     |
| 30       | $\frac{(x^2 + x + 1)(x^5 + 5x^4 - x - 5)}{(2x^4 + 10x^3 - 2x - 10)(x^3 + x^2 + x + 1)}$                                | $\frac{1}{2}$         |

## 1.2. Раскрыть скобки и привести подобные слагаемые:

| №<br>п/п | Раскройте скобки         | Ответ                          |
|----------|--------------------------|--------------------------------|
| 1        | $(x-2)(x^2+5)(x+2)$      | $x^4+x^2-20$                   |
| 2        | $(x+6)(2x+3)(3x+5)$      | $6x^3+55x^2+129x+90$           |
| 3        | $(x-10)(x+4)^3$          | $x^4+2x^3-72x^2-416x-640$      |
| 4        | $2(x-1)(x+1)^3$          | $2x^4+4x^3-4x-2$               |
| 5        | $9(x-1)^2(x+2)^3$        | $9x^5+36x^4+9x^3-90x^2-36x+72$ |
| 6        | $(x-1)^3(x+4)$           | $x^4+x^3-9x^2+11x-4$           |
| 7        | $2(x+2)(x+6)(3x+7)$      | $6x^3+62x^2-184x+168$          |
| 8        | $(x+3)(x+4)(x^2+9)$      | $x^4+7x^3+21x^2+63x+108$       |
| 9        | $x(x-3)(3x+10)(x+3)^2$   | $3x^5+19x^4+3x^3-171x^2-270x$  |
| 10       | $(x-3)(x+3)(x+4)(x^2+9)$ | $4x^4+x^5-81x-324$             |
| 11       | $(3x+10)(x+3)^2$         | $3x^3+28x^2+87x+90$            |
| 12       | $2(x-2)(x+5)(x^2+2x+4)$  | $2x^4+10x^3-16x-80$            |
| 13       | $(x-2)(x+2)(x+5)(x^2+4)$ | $x^5+5x^4-16x-80$              |
| 14       | $x^2(x-5)(x+3)^2$        | $x^5+x^4-21x^3-45x^2$          |
| 15       | $(x^2-5)(x+3)^2$         | $x^4+6x^3+4x^2-30x-45$         |
| 16       | $(x+2)(2x+3)(2x^2+5)$    | $4x^4+14x^3+22x^2+35x+30$      |
| 17       | $2(x-2)(x+2)^2(x+5)$     | $2x^4+14x^3+12x^2-56x-80$      |
| 18       | $x(x-3)(x+4)(x^3+4)$     | $x^6+x^5-12x^4+4x^3+4x^2-48x$  |
| 19       | $(x+2)(2x-3)(x^3+4)$     | $2x^5+x^4-6x^3+8x^2+4x-24$     |
| 20       | $(x-7)(4x-3)(x^2+3)$     | $4x^4-31x^3+33x^2-93x+63$      |
| 21       | $(x-6)(x-5)(2x-3)$       | $2x^3-25x^2+93x-90$            |
| 22       | $2(x-4)(7x+5)(x^2-3)$    | $14x^4-46x^3-82x^2+138x+120$   |
| 23       | $(x-2)(x+2)^2(3x-5)$     | $3x^4+x^3-22x^2-4x+40$         |
| 24       | $(x-2)(x+2)(x+3)(6x+5)$  | $6x^4+23x^3-9x^2-92x-60$       |
| 25       | $4(x-1)(x+1)(x+3)(4x+7)$ | $16x^4+76x^3+68x^2-76x-84$     |
| 26       | $-(x-3)(x+4)(x^3+5)$     | $-x^5-x^4+12x^3-5x^2-5x+60$    |
| 27       | $-2(x-4)(x+3)(2x+5)$     | $-4x^3-6x^2+58x+120$           |
| 28       | $x(x+9)(x^2+7)$          | $x^4+9x^3+7x^2+63x$            |
| 29       | $-(x-9)(x-7)(x^2+4)$     | $-x^4+16x^3-67x^2+64x-252$     |
| 30       | $(x+4)(x+8)(5x-4)$       | $5x^3+56x^2+112x-128$          |

### 1.3. Разложить алгебраическое выражение на множители:

| №<br>п/п | Разложите на множители                   | Ответ                            |
|----------|--|----------------------------------|
| 1        | $x^3 + 2x^2 + 4x + 8$                    | $(x + 2)(x^2 + 4)$               |
| 2        | $x^4 + 9x^3 + 7x^2 + 63x$                | $x(x + 9)(x^2 + 7)$              |
| 3        | $5x^3 + 56x^2 + 112x - 128$              | $(x + 4)(x + 8)(5x - 4)$         |
| 4        | $14x^4 - 46x^3 - 82x^2 + 138x + 120$     | $2(x - 4)(7x + 5)(x^2 - 3)$      |
| 5        | $3x^4 + x^3 - 22x^2 - 4x + 40$           | $(x - 2)(x + 2)^2(3x - 5)$       |
| 6        | $x^6 + x^5 - 12x^4 + 4x^3 + 4x^2 - 48x$  | $x(x - 3)(x + 4)(x^3 + 4)$       |
| 7        | $4x^4 - 31x^3 + 33x^2 - 93x + 63$        | $(x - 7)(4x - 3)(x^2 + 3)$       |
| 8        | $16x^4 + 76x^3 + 68x^2 - 76x - 84$       | $4(x - 1)(x + 1)(x + 3)(4x + 7)$ |
| 9        | $-4x^3 - 6x^2 + 58x + 120$               | $-2(x - 4)(x + 3)(2x + 5)$       |
| 10       | $-x^4 + 16x^3 - 67x^2 + 64x - 252$       | $-(x - 9)(x - 7)(x^2 + 4)$       |
| 11       | $6x^4 + 23x^3 - 9x^2 - 92x - 60$         | $(x - 2)(x + 2)(x + 3)(6x + 5)$  |
| 12       | $-x^5 - x^4 + 12x^3 - 5x^2 - 5x + 60$    | $-(x - 3)(x + 4)(x^3 + 5)$       |
| 13       | $6x^3 + 62x^2 - 184x + 168$              | $2(x + 2)(x + 6)(3x + 7)$        |
| 14       | $x^4 + x^2 - 20$                         | $(x - 2)(x^2 + 5)(x + 2)$        |
| 15       | $x^4 + x^3 - 9x^2 + 11x - 4$             | $(x - 1)^3(x + 4)$               |
| 16       | $2x^4 + 10x^3 - 16x - 80$                | $2(x - 2)(x + 5)(x^2 + 2x + 4)$  |
| 17       | $4x^4 + x^5 - 81x - 324$                 | $(x - 3)(x + 3)(x + 4)(x^2 + 9)$ |
| 18       | $x^5 + x^4 - 21x^3 - 45x^2$              | $x^2(x - 5)(x + 3)^2$            |
| 19       | $x^4 + 7x^3 + 21x^2 + 63x + 108$         | $(x + 3)(x + 4)(x^2 + 9)$        |
| 20       | $3x^3 + 28x^2 + 87x + 90$                | $(3x + 10)(x + 3)^2$             |
| 21       | $3x^5 + 19x^4 + 3x^3 - 171x^2 - 270x$    | $x(x - 3)(3x + 10)(x + 3)^2$     |
| 22       | $x^5 + 5x^4 - 16x - 80$                  | $(x - 2)(x + 2)(x + 5)(x^2 + 4)$ |
| 23       | $x^4 + 6x^3 + 4x^2 - 30x - 45$           | $(x^2 - 5)(x + 3)^2$             |
| 24       | $2x^4 + 14x^3 + 12x^2 - 56x - 80$        | $2(x - 2)(x + 2)^2(x + 5)$       |
| 25       | $2x^5 + x^4 - 6x^3 + 8x^2 + 4x - 24$     | $(x + 2)(2x - 3)(x^3 + 4)$       |
| 26       | $2x^3 - 25x^2 + 93x - 90$                | $(x - 6)(x - 5)(2x - 3)$         |
| 27       | $6x^3 + 55x^2 + 129x + 90$               | $(x + 6)(2x + 3)(3x + 5)$        |
| 28       | $x^4 + 2x^3 - 72x^2 - 416x - 640$        | $(x - 10)(x + 4)^3$              |
| 29       | $2x^4 + 4x^3 - 4x - 2$                   | $2(x - 1)(x + 1)^3$              |
| 30       | $9x^5 + 36x^4 + 9x^3 - 90x^2 - 36x + 72$ | $9(x - 1)^2(x + 2)^3$            |

**1.4. Разложить рациональную дробь на простейшие дроби:**

|    |   |    |  |
|----|---|----|--|
| 1  | $\frac{5x^4 + 7x^3 + 5x - 4}{(x^2 + 4)(x - 2)^2(x^2 - 1)}$        | 16 | $\frac{x^4 + x^3 - 5x - 7}{(x^2 + 4x + 1)(x - 2)^2(x^2 - 1)}$    |
| 2  | $\frac{3x^5 + 6x^3 + 5x - 1}{(x^2 - 4x + 3)(x - 2)^2(x^2 - 16)}$  | 17 | $\frac{x^6 + 2x - 1}{(x^2 - x + 5)(x - 3)^3(x^2 - 1)}$           |
| 3  | $\frac{x^3 + 2x^2 + 3x + 4}{(x^2 - x)(3 - x)^3(x^2 - 81)}$        | 18 | $\frac{x^4 + x^3 - 5x - 7}{(x^2 + 4x + 1)(x - 2)^2(x^2 - 1)}$    |
| 4  | $\frac{x^5 - 7x^4 + 2x - 8}{(x^3 - 4x^2 + 5x)(x - 3)^2(x^2 - 1)}$ | 19 | $\frac{2x^6 - 3x^4 + 9}{(x^2 - 2x - 15)(4x + 1)^3x}$             |
| 5  | $\frac{x^5 + 2x^3 + 9x^2 - 7}{(4x^2 - 6x - 10)(5x + 3)^2x}$       | 20 | $\frac{x^5 + 2x^3 + 9x^2 - 7}{(2x^2 - 6x + 1)(4x + 2)x^3}$       |
| 6  | $\frac{6x^6 + 4x^2 + 9x}{(x^2 - 4)(2 - 3x)^3(x^2 - 4)}$           | 21 | $\frac{3x^5 + x^2 + 4x}{(3x^2 - 6x)(x + 2)^4x^2}$                |
| 7  | $\frac{2x^7 + 4x^2 + 1}{(25x^2 - 30x - 5)(3x^2 + x)^2}$           | 22 | $\frac{5x^6 + 9x^3 + 10x + 15}{(5x^2 - 125)(6x^2 + 2x)^2}$       |
| 8  | $\frac{x^6 + 3x^3 + 4x + 12}{(x^2 - 25)(3x^2 + 9x)^3}$            | 23 | $\frac{7x^5 - 5x^6 + 1}{(x^2 + 8x)x^3(x^2 - 9)^2}$               |
| 9  | $\frac{x^7 + 2x^5 + 15x + 14}{(x^2 + 5x + 13)(3x - 6)^4}$         | 24 | $\frac{x^7 + 2x^6 + 5x + 51}{(x^2 + 3x + 1)x^2(x^2 - 4)^3}$      |
| 10 | $\frac{3x^4 + 3x + 4}{(x^2 - 1)(2 - x)^3(x^2 - 9)}$               | 25 | $\frac{4x^4 + 5x^3 + 2x - 1}{(x^2 - 4x + 5)(x - 1)^2(x^2 - 9)}$  |
| 11 | $\frac{3x^5 + x^2 + 4x}{(5x^2 + 6x - 1)(x + 2)^3(x - 3)}$         | 26 | $\frac{6x^5 + 3x^3 + 4x + 1}{(5x^2 + 6x - 1)(x + 4)^3(x^2 - 4)}$ |
| 12 | $\frac{7x^5 - 3x^3 + 7x + 77}{(x^2 + 10x + 25)(x^2 - 9)^2}$       | 27 | $\frac{4x^7 + 9x^6 + x + 5}{(x^2 + 3x)x^2(x^2 - 25)^3}$          |
| 13 | $\frac{8x^5 - 14x^3 + 34}{x(x^2 - x)(7 - x)^3}$                   | 28 | $\frac{5x^6 + x^5 - 4x + 21}{(2x^2 + x + 14)(3 - 6x)^4}$         |
| 14 | $\frac{x^6 + 4x^3 - 14x^2 + 35}{x(2x^2 + x)(5 - 2x)^4}$           | 29 | $\frac{x^6 - 3x^3 + 6x + 11}{(x^2 - 10x + 25)(3x^2 + 9)^3}$      |
| 15 | $\frac{4x^2 - 3x^3 - x}{(x^2 - 2x + 1)(4x + 1)^2(x^2 - 64)}$      | 30 | $\frac{x^5 - 2x^3 + 9x^2 + 4}{(x^2 - 6x + 1)(x + 2)x^4}$         |

### 1.5. Построить графики многочленов и найти все их корни:

| №  | Уравнение для многочленов $y = f_n(x)$             |
|----|--|
| 1  | $12x^5 + 108x^4 + 315x^3 + 360x^2 + 303x + 252$    |
| 2  | $x^5 - 15x^4 + 85x^3 - 225x^2 + 274x - 120$        |
| 3  | $x^5 - 87x^3 + 82x^2 + 1032x - 1728$               |
| 4  | $x^5 - 4x^4 - 36x^3 + 226x^2 - 397x + 210$         |
| 5  | $x^5 - 2x^4 - 45x^3 + 230x^2 - 376x + 192$         |
| 6  | $7x^5 - 99x^4 + 511x^3 - 1149x^2 + 994x - 120$     |
| 7  | $2x^5 - 9x^4 - 34x^3 + 231x^2 - 346x + 120$        |
| 8  | $3x^5 - 50x^4 + 299x^3 - 760x^2 + 748x - 240$      |
| 9  | $4x^5 - 79x^4 + 533x^3 - 1481x^2 + 1563x - 540$    |
| 10 | $2x^5 - 47x^4 + 423x^3 - 1822x^2 + 3736x - 2880$   |
| 11 | $7x^5 - 25x^4 - 37x^3 + 217x^2 - 234x + 72$        |
| 12 | $2x^5 - 11x^4 - 41x^3 + 404x^2 - 948x + 720$       |
| 13 | $x^5 + 5x^4 + 7x^3 - x^2 - 8x - 4$                 |
| 14 | $6x^5 - 65x^4 + 195x^3 + 5x^2 - 561x + 180$        |
| 15 | $6x^5 + 15x^4 - 372x^3 + 771x^2 - 120x - 300$      |
| 16 | $3x^5 + 7x^4 - 115x^3 - 63x^2 + 412x + 140$        |
| 17 | $4x^5 - 61x^3 - 28x^2 + 57x + 28$                  |
| 18 | $16x^5 + 76x^4 - 588x^3 - 1272x^2 + 1112x + 2240$  |
| 19 | $4x^5 + 39x^4 - 44x^3 - 687x^2 - 320x + 1008$      |
| 20 | $6x^5 - 5x^4 - 73x^3 + 40x^2 + 200x$               |
| 21 | $x^5 - 15x^4 + 85x^3 - 225x^2 + 274x - 120$        |
| 22 | $8x^5 + 36x^4 - 158x^3 - 81x^2 + 315x$             |
| 23 | $24x^5 + 172x^4 - 186x^3 - 1507x^2 + 297x + 2520$  |
| 24 | $12x^5 + 40x^4 - 547x^3 - 778x^2 + 136x + 192$     |
| 25 | $81x^5 + 675x^4 - 846x^3 - 3144x^2 + 1248x + 3456$ |
| 26 | $64x^5 + 64x^4 - 564x^3 - 4x^2 + 35x$              |
| 27 | $2x^5 + 8x^2 + x^4 + 4x - 6x^3 - 24$               |
| 28 | $x^5 + 5x^4 - 16x - 80$                            |
| 29 | $3x^5 + 10x^4 - 81x^3 - 270x$                      |
| 30 | $9x^5 + 36x^4 + 9x^3 - 90x^2 - 36x + 72$           |



**1.6. Графически исследовать решение нелинейных уравнений и для каждого корня получить решение:**

|    |   |    |   |
|----|---|----|---|
| №  | Уравнение   | №  | Уравнение   |
| 1  | $\ln^2(x-1) = 3 \cos 2x + 1$  | 16 | $\sqrt{25-x^2} = \operatorname{arctg} 2x$                     |
| 2  | $\frac{3\pi}{2} \cos x = e^{0.1x^2} \cdot \operatorname{arctg} 2x$  | 17 | $\sin x \cdot \sqrt{81-x^2} = 5x \operatorname{arctg} x$      |
| 3  | $10e^{-x^2} = \sqrt{2\pi x} + \sin x$                               | 18 | $\operatorname{arctg} 2x - 0.2(x-1)^4 + \sin x = 0$           |
| 4  | $\sqrt{\ln^2(x-1)} e^{\sin 3x} = 10e^{-0.1x^2}$                     | 19 | $\sin 3x \cdot \sqrt{64-x^2} = 5xe^{0.1x}$                    |
| 5  | $\sqrt{36-x^2} \lg x = \sin 4x$                                     | 20 | $\operatorname{arctg} 2x - \frac{(x-1)^4}{5} + \sin^2 5x = 0$ |
| 6  | $\frac{10}{1+x^2} = 2 \sin 2x + x$                                  | 21 | $10e^{-0.1x^2} = \sqrt{2\pi + x} + \sin 2x$                   |
| 7  | $\sin 4x \cdot \sqrt{81-25x^2} = 5x \operatorname{arctg} x$         | 22 | $\sin^2 3x \cdot \sqrt{16-x^2} = 5xe^{0.2x}$                  |
| 8  | $\frac{10x}{1+x^2} = 2 \cos 2x + x$                                 | 23 | $\frac{x^2-4}{x^2+1} = \sqrt{x} e^{x \sin x}$                 |
| 9  | $\arcsin x - \sin 5x \cdot \sqrt[4]{1-x^4} = 0$                     | 24 | $4x \operatorname{tg}(0.5\sqrt{9-x^2}) = 10 \sin 3x$          |
| 10 | $\frac{x^2-4x}{x^2-4x+8} = \sqrt[3]{x^3+4} e^{\cos 3x}$             | 25 | $\frac{x-1}{x^2-2x+2} = \sqrt[4]{x^4+4} e^{\sin 2x}$          |
| 11 | $\frac{10x-2}{3+x^2} = 2 \cos 2x + \sqrt[4]{x}$                     | 26 | $\frac{x^2-9}{x^2+4} = \sqrt{x^2+1} e^{x \cos x}$             |
| 12 | $\sqrt{64-x^2} \log_2 x = \sin 3x$                                  | 27 | $\frac{x^2-4}{x^2+1} = \sqrt{x} e^{x \sin x}$                 |
| 13 | $10e^{-0.3x^2} = \sqrt{2\pi x + x^2} + 3 \sin x$                    | 28 | $4x \operatorname{tg}(0.5\sqrt{9-x^2}) = 10 \sin 3x$          |
| 14 | $5 \cdot 3^{-x^2} + 1 = \sqrt{3x} + \sin 2x$                        | 29 | $\operatorname{arctg} 2x - (x-0.1)^4 + \sin^2 x = 0$          |
| 15 | $\frac{5\pi}{2} \cos 2x = 3^{0.1x^2} \cdot \operatorname{arctg} 2x$ | 30 | $\sin^2 x \cdot \sqrt{81-x^2} = 5e^{-x^2}$                    |

## Раздел 2. Решение задач математического анализа

### 2.1. Вычислить пределы числовых последовательностей

#### 2.1. (а) Полиномиальные выражения:

$$\text{a.1. } \lim_{n \rightarrow \infty} \frac{(3-n)^2 + (3+n)^2}{(3-n)^2 - (3+n)^2}.$$

$$\text{a.2. } \lim_{n \rightarrow \infty} \frac{(3-n)^4 - (2-n)^4}{(1-n)^4 - (1+n)^4}.$$

$$\text{a.3. } \lim_{n \rightarrow \infty} \frac{(3-n)^4 - (2-n)^4}{(1-n)^3 - (1+n)^3}.$$

$$\text{a.4. } \lim_{n \rightarrow \infty} \frac{(1-n)^4 - (1+n)^4}{(1+n)^3 - (1-n)^3}.$$

$$\text{a.5. } \lim_{n \rightarrow \infty} \frac{(6-n)^2 - (6+n)^2}{(6+n)^2 - (1-n)^2}.$$

$$\text{a.6. } \lim_{n \rightarrow \infty} \frac{(n+1)^3 - (n+1)^2}{(n-1)^3 - (n+1)^3}.$$

$$\text{a.7. } \lim_{n \rightarrow \infty} \frac{(1+2n)^3 - 8n^3}{(1+2n)^2 + 4n^2}.$$

$$\text{a.8. } \lim_{n \rightarrow \infty} \frac{(3-4n)^2}{(n-3)^3 - (n+3)^3}.$$

$$\text{a.9. } \lim_{n \rightarrow \infty} \frac{(3-n)^3}{(n+1)^2 - (n+1)^3}.$$

$$\text{a.10. } \lim_{n \rightarrow \infty} \frac{(n+1)^2 + (n-1)^2 - (n+2)^3}{(4-n)^3}.$$

$$\text{a.11. } \lim_{n \rightarrow \infty} \frac{2(n+1)^3 - (n-2)^3}{n^2 + 2n - 3}.$$

$$\text{a.12. } \lim_{n \rightarrow \infty} \frac{(n+1)^3 + (n+2)^3}{(n+4)^3 + (n+5)^3}.$$

$$\text{a.13. } \lim_{n \rightarrow \infty} \frac{(n+3)^3 + (n+4)^3}{(n+3)^4 - (n+4)^4}.$$

$$\text{a.14. } \lim_{n \rightarrow \infty} \frac{(n+1)^4 - (n-1)^4}{(n+1)^3 + (n-1)^3}.$$

$$\text{a.15. } \lim_{n \rightarrow \infty} \frac{8n^3 - 2n}{(n+1)^4 - (n-1)^4}.$$

$$\text{a.16. } \lim_{n \rightarrow \infty} \frac{(n+6)^3 - (n+1)^3}{(2n+3)^2 + (n+4)^2}.$$

$$\text{a.17. } \lim_{n \rightarrow \infty} \frac{(2n-3)^3 - (n+5)^3}{(3n-1)^3 + (2n+3)^3}.$$

$$\text{a.18. } \lim_{n \rightarrow \infty} \frac{(n+10)^2 + (3n+1)^2}{(n+6)^3 - (n+1)^3}.$$

$$\text{a.19. } \lim_{n \rightarrow \infty} \frac{(2n+1)^3 + (3n+2)^3}{(2n+3)^3 - (n-7)^3}.$$

$$\text{a.20. } \lim_{n \rightarrow \infty} \frac{(n+7)^3 - (n+2)^3}{(3n+2)^2 + (4n+1)^2}.$$

$$a.21. \lim_{n \rightarrow \infty} \frac{(2n+1)^3 - (2n+3)^3}{(2n+1)^2 + (2n+3)^2}.$$

$$a.22. \lim_{n \rightarrow \infty} \frac{n^3 - (n-1)^3}{(n+1)^4 - n^4}.$$

$$a.23. \lim_{n \rightarrow \infty} \frac{(n+2)^4 - (n-2)^4}{(n+5)^2 + (n-5)^2}.$$

$$a.24. \lim_{n \rightarrow \infty} \frac{(n+1)^4 - (n-1)^4}{(n+1)^3 + (n-1)^3}.$$

$$a.25. \lim_{n \rightarrow \infty} \frac{(n+1)^3 - (n-1)^3}{(n+1)^2 - (n-1)^2}.$$

$$a.26. \lim_{n \rightarrow \infty} \frac{(n+1)^3 - (n-1)^3}{(n+1)^2 + (n-1)^2}.$$

$$a.27. \lim_{n \rightarrow \infty} \frac{(n+2)^3 + (n-2)^3}{n^4 + 2n^2 - 1}.$$

$$a.28. \lim_{n \rightarrow \infty} \frac{(n+1)^3 + (n-1)^3}{n^3 - 3n}.$$

$$a.29. \lim_{n \rightarrow \infty} \frac{(n+1)^3 + (n-1)^3}{n^3 + 1}.$$

$$a.30. \lim_{n \rightarrow \infty} \frac{(n+2)^2 - (n-2)^2}{(n+3)^2}.$$

### 2.1. (b) Выражения с радикалами:

$$b.1. \lim_{n \rightarrow \infty} \frac{n \sqrt[3]{5n^2} + \sqrt[4]{9n^8 + 1}}{(n + \sqrt{n})\sqrt{7 - n + n^2}}.$$

$$b.2. \lim_{n \rightarrow \infty} \frac{\sqrt{n-1} - \sqrt{n^2 + 1}}{\sqrt[3]{3n^3 + 3} + \sqrt[4]{n^5 + 1}}.$$

$$b.3. \lim_{n \rightarrow \infty} \frac{\sqrt{n^3 + 1} - \sqrt{n-1}}{\sqrt[3]{n^3 + 1} - \sqrt{n-1}}.$$

$$b.4. \lim_{n \rightarrow \infty} \frac{\sqrt[3]{n^2 - 1} + 7n^3}{\sqrt[4]{n^{12} + n + 1} - n}.$$

$$b.5. \lim_{n \rightarrow \infty} \frac{\sqrt{3n-1} - \sqrt[3]{125n^3 + n}}{\sqrt[5]{n} - n}.$$

$$b.6. \lim_{n \rightarrow \infty} \frac{n \sqrt[5]{n} - \sqrt[3]{27n^6 + n^2}}{(n + \sqrt[4]{n})\sqrt{9 + n^2}}.$$

$$b.7. \lim_{n \rightarrow \infty} \frac{\sqrt{n+2} - \sqrt{n^2 + 2}}{\sqrt[4]{4n^4 + 1} - \sqrt[3]{n^4 - 1}}.$$

$$b.8. \lim_{n \rightarrow \infty} \frac{\sqrt{n^4 + 2} + \sqrt{n-2}}{\sqrt[4]{n^4 + 2} + \sqrt{n-2}}.$$

$$b.9. \lim_{n \rightarrow \infty} \frac{6n^3 - \sqrt{n^5 + 1}}{\sqrt{4n^6 + 3} - n}.$$

$$b.10. \lim_{n \rightarrow \infty} \frac{\sqrt{5n+2} - \sqrt[3]{8n^3 + 5}}{\sqrt[4]{n+7} - n}.$$

$$b.11. \lim_{n \rightarrow \infty} \frac{n \sqrt[4]{3n+1} + \sqrt{81n^4 - n^2 + 1}}{(n + \sqrt[3]{n})\sqrt{5 - n + n^2}}.$$

$$b.12. \lim_{n \rightarrow \infty} \frac{\sqrt{n+3} - \sqrt{n^2 - 3}}{\sqrt[3]{n^5 - 4} - \sqrt[4]{n^4 + 1}}.$$

$$\text{b.13. } \lim_{n \rightarrow \infty} \frac{\sqrt{n^5 + 3} - \sqrt{n-3}}{\sqrt[5]{n^5 + 3} + \sqrt{n-3}}.$$

$$\text{b.14. } \lim_{n \rightarrow \infty} \frac{\sqrt[3]{n} - 9n^2}{3n - \sqrt[4]{9n^8 + 1}}.$$

$$\text{b.15. } \lim_{n \rightarrow \infty} \frac{\sqrt{4n+1} - \sqrt[3]{27n^3 + 4}}{\sqrt[4]{n} - \sqrt[3]{n^5 + n}}.$$

$$\text{b.16. } \lim_{n \rightarrow \infty} \frac{n \sqrt[3]{7n} - \sqrt[4]{81n^8 - 1}}{(n + 4\sqrt{n})\sqrt{n^2 - 5}}.$$

$$\text{b.17. } \lim_{n \rightarrow \infty} \frac{\sqrt[3]{n^3 - 7} + \sqrt[3]{n^2 + 4}}{\sqrt[4]{n^5 + 5} + \sqrt{n}}.$$

$$\text{b.18. } \lim_{n \rightarrow \infty} \frac{\sqrt{n^6 + 4} + \sqrt{n-4}}{\sqrt[5]{n^6 + 6} - \sqrt{n-6}}.$$

$$\text{b.19. } \lim_{n \rightarrow \infty} \frac{4n^2 - \sqrt[4]{n^3}}{\sqrt[3]{n^6 + n^3 + 1} - 5n}.$$

$$\text{b.20. } \lim_{n \rightarrow \infty} \frac{\sqrt{n+3} - \sqrt[3]{8n^3 + 3}}{\sqrt[4]{n+4} - \sqrt[5]{n^5 + 5}}.$$

$$\text{b.21. } \lim_{n \rightarrow \infty} \frac{n \sqrt[4]{11n} + \sqrt{25n^4 - 81}}{(n - 7\sqrt{n})\sqrt{n^2 - n + 1}}.$$

$$\text{b.22. } \lim_{n \rightarrow \infty} \frac{\sqrt[3]{n^2} - \sqrt{n^2 + 5}}{\sqrt[5]{n^7} - \sqrt{n+1}}.$$

$$\text{b.23. } \lim_{n \rightarrow \infty} \frac{\sqrt{n^7 + 5} - \sqrt{n-5}}{\sqrt[7]{n^7 + 5} + \sqrt{n-5}}.$$

$$\text{b.24. } \lim_{n \rightarrow \infty} \frac{\sqrt[3]{n^2 + 2} - 5n^2}{n - \sqrt{n^4 - n + 1}}.$$

$$\text{b.25. } \lim_{n \rightarrow \infty} \frac{\sqrt{n+2} - \sqrt[3]{n^3 + 2}}{\sqrt[7]{n+2} - \sqrt[5]{n^5 + 2}}.$$

$$\text{b.26. } \lim_{n \rightarrow \infty} \frac{n \sqrt{71n} - \sqrt[3]{64n^6 + 9}}{(n - \sqrt[3]{n})\sqrt{11 + n^2}}.$$

$$\text{b.27. } \lim_{n \rightarrow \infty} \frac{\sqrt{n+6} - \sqrt{n^2 - 5}}{\sqrt[3]{n^3 + 3} + \sqrt[4]{n^3 + 1}}.$$

$$\text{b.28. } \lim_{n \rightarrow \infty} \frac{\sqrt{n^8 + 6} - \sqrt{n-6}}{\sqrt[8]{n^8 + 6} + \sqrt{n-6}}.$$

$$\text{b.29. } \lim_{n \rightarrow \infty} \frac{n^2 - \sqrt{n^3 + 1}}{\sqrt[3]{n^6 + 2} - n}.$$

$$\text{b.30. } \lim_{n \rightarrow \infty} \frac{\sqrt{n+1} - \sqrt[3]{n^3 + 1}}{\sqrt[4]{n+1} - \sqrt[5]{n^5 + 1}}.$$

### 2.1. (с) Выражения с числовыми рядами:

$$\text{c.1. } \lim_{n \rightarrow \infty} \left( \frac{1}{n^2} + \frac{2}{n^2} + \frac{3}{n^2} + \dots + \frac{n-1}{n^2} \right).$$

$$\text{c.2. } \lim_{n \rightarrow \infty} \frac{(2n+1)! + (2n+2)!}{(2n+3)!}.$$

$$\text{c.3. } \lim_{n \rightarrow \infty} \left[ \frac{1+3+5+7+\dots+(2n-1)}{n+1} - \frac{2n+1}{2} \right].$$

$$\text{c.4. } \lim_{n \rightarrow \infty} \frac{2^{n+1} + 3^{n+1}}{2^n + 3^n}.$$

$$\text{c.5. } \lim_{n \rightarrow \infty} \frac{1+2+3+\dots+n}{\sqrt{9n^4+1}}.$$

$$\text{c.6. } \lim_{n \rightarrow \infty} \frac{1+3+5+\dots+(2n-1)}{1+2+3+\dots+n}.$$

$$\text{c.7. } \lim_{n \rightarrow \infty} \left[ \frac{1+3+5+7+\dots+(2n-1)}{n+3} - n \right].$$

$$\text{c.8. } \lim_{n \rightarrow \infty} \frac{1+4+7+\dots+(3n-2)}{\sqrt{5n^4+n+1}}.$$

$$\text{c.9. } \lim_{n \rightarrow \infty} \frac{(n+4)! - (n+2)!}{(n+3)!}.$$

$$\text{c.10. } \lim_{n \rightarrow \infty} \frac{(3n-1)! + (3n+1)!}{(3n)!(n-1)}.$$

$$\text{c.11. } \lim_{n \rightarrow \infty} \frac{2^n - 5^{n+1}}{2^{n+1} + 5^{n+2}}.$$

$$\text{c.12. } \lim_{n \rightarrow \infty} \frac{1 + \frac{1}{3} + \frac{1}{3^2} + \dots + \frac{1}{3^n}}{1 + \frac{1}{5} + \frac{1}{5^2} + \dots + \frac{1}{5^n}}.$$

$$\text{c.13. } \lim_{n \rightarrow \infty} \frac{1-3+5-7+9-11+\dots+(4n-3)-(4n-1)}{\sqrt{n^2+1} + \sqrt{n^2+n+1}}.$$

$$\text{c.14. } \lim_{n \rightarrow \infty} \frac{1-2+3-4+\dots+(2n-1)-2n}{\sqrt{9n^4+1}}.$$

$$\text{c.15. } \lim_{n \rightarrow \infty} \frac{\sqrt[3]{n^3+5} - \sqrt{3n^4+2}}{1+3+5+\dots+(2n-1)}.$$

$$\text{c.16. } \lim_{n \rightarrow \infty} \frac{3^n - 2^n}{3^{n-1} + 2^n}.$$

$$\text{c.17. } \lim_{n \rightarrow \infty} \left[ \frac{n+2}{1+2+3+\dots+n} - \frac{2}{3} \right].$$

$$\text{c.18. } \lim_{n \rightarrow \infty} \left( \frac{5}{6} + \frac{13}{36} + \dots + \frac{3^n + 2^n}{6^n} \right).$$

$$c.19. \lim_{n \rightarrow \infty} \frac{2 - 5 + 4 - 7 + \dots + 2n - (2n + 3)}{n + 3}.$$

$$c.20. \lim_{n \rightarrow \infty} \frac{(2n + 1)! + (2n + 2)!}{(2n + 3)! - (2n + 2)!}.$$

$$c.21. \lim_{n \rightarrow \infty} \frac{1 + 2 + \dots + n}{n - n^2 + 3}.$$

$$c.22. \lim_{n \rightarrow \infty} \frac{n^2 + \sqrt{n} - 1}{2 + 7 + 12 + \dots + (5n - 3)}.$$

$$c.23. \lim_{n \rightarrow \infty} \left( \frac{3}{4} + \frac{5}{16} + \frac{9}{64} + \dots + \frac{1 + 2^n}{4^n} \right).$$

$$c.24. \lim_{n \rightarrow \infty} \frac{2 + 4 + 6 + \dots + 2n}{1 + 3 + 5 + \dots + (2n - 1)}.$$

$$c.25. \lim_{n \rightarrow \infty} \left[ \frac{1 + 5 + 9 + 13 + \dots + (4n - 3)}{n + 1} - \frac{4n + 1}{2} \right].$$

$$c.26. \lim_{n \rightarrow \infty} \frac{1 - 2 + 3 - 4 + \dots - 2n}{\sqrt[3]{n^3 + 2n + 2}}.$$

$$c.27. \lim_{n \rightarrow \infty} \frac{2^n + 7^n}{2^n - 7^{n-1}}.$$

$$c.28. \lim_{n \rightarrow \infty} \frac{n! + (n + 2)!}{(n - 1)! + (n + 2)!}.$$

$$c.29. \lim_{n \rightarrow \infty} \frac{3 + 6 + 9 + \dots + 3n}{n^2 + 4}.$$

$$c.30. \lim_{n \rightarrow \infty} \left( \frac{7}{10} + \frac{29}{100} + \dots + \frac{2^n + 5^n}{10^n} \right).$$

## 2.2. Вычислить пределы функций

### 2.2. (d) Рациональные функции:

$$d.1. \lim_{x \rightarrow -1} \frac{(x^3 - 2x - 1)(x + 1)}{x^4 + 4x^2 - 5}.$$

$$d.2. \lim_{x \rightarrow -1} \frac{x^3 - 3x - 2}{x + x^2}.$$

$$d.3. \lim_{x \rightarrow -1} \frac{(x^2 + 3x + 2)^2}{x^3 + 2x^2 - x - 2}.$$

$$d.4. \lim_{x \rightarrow 1} \frac{(2x^2 - x - 1)^2}{x^3 + 2x^2 - x - 2}.$$

$$d.5. \lim_{x \rightarrow -3} \frac{(x^2 + 2x - 3)^2}{x^3 + 4x^2 + 3x}.$$

$$d.6. \lim_{x \rightarrow -1} \frac{(x^3 - 2x - 1)^2}{x^4 + 2x + 1}.$$

$$d.7. \lim_{x \rightarrow 0} \frac{(1+x)^3 - (1+3x)}{x + x^5}.$$

$$d.8. \lim_{x \rightarrow 1} \frac{x^2 - 2x + 1}{2x^2 - x - 1}.$$

$$d.9. \lim_{x \rightarrow -1} \frac{x^3 - 3x - 2}{x^2 - x - 2}.$$

$$d.10. \lim_{x \rightarrow -1} \frac{x^3 + 5x^2 + 7x + 3}{x^3 + 4x^2 + 5x + 2}.$$

$$d.11. \lim_{x \rightarrow 1} \frac{x^3 - 3x + 2}{x^3 - x^2 - x + 1}.$$

$$d.12. \lim_{x \rightarrow 1} \frac{x^3 + x^2 - 5x + 3}{x^3 - x^2 - x + 1}.$$

$$d.13. \lim_{x \rightarrow -1} \frac{x^3 + 4x^2 + 5x + 2}{x^3 - 3x - 2}.$$

$$d.14. \lim_{x \rightarrow 1} \frac{x^4 - 1}{2x^4 - x^2 - 1}.$$

$$d.15. \lim_{x \rightarrow -2} \frac{x^3 + 5x^2 + 8x + 4}{x^3 + 3x^2 - 4}.$$

$$d.16. \lim_{x \rightarrow 2} \frac{x^3 - 5x^2 + 8x - 4}{x^3 - 3x^2 + 4}.$$

$$d.17. \lim_{x \rightarrow 2} \frac{x^3 - 6x^2 + 12x - 8}{x^3 - 3x^2 + 4}.$$

$$d.18. \lim_{x \rightarrow -2} \frac{x^3 + 5x^2 + 8x + 4}{x^3 + 7x^2 + 16x + 12}.$$

$$d.19. \lim_{x \rightarrow -1} \frac{x^3 - 3x - 2}{(x^2 - x - 2)^2}.$$

$$d.20. \lim_{x \rightarrow 2} \frac{x^3 - 3x - 2}{x - 2}.$$

$$d.21. \lim_{x \rightarrow -1} \frac{x^3 - 3x - 2}{x^2 + 2x + 1}.$$

$$d.22. \lim_{x \rightarrow 1} \frac{x^2 - 2x + 1}{x^3 - x^2 - x + 1}.$$

$$d.23. \lim_{x \rightarrow 1} \frac{x^4 - 1}{2x^4 - x^2 - 1}.$$

$$d.24. \lim_{x \rightarrow -1} \frac{x^2 + 3x + 2}{x^3 + 2x^2 - x - 2}.$$

$$d.25. \lim_{x \rightarrow 1} \frac{2x^2 - x - 1}{x^3 + 2x^2 - x - 2}.$$

$$d.26. \lim_{x \rightarrow -3} \frac{x^2 + 2x - 3}{x^3 + 4x^2 + 3x}.$$

$$d.27. \lim_{x \rightarrow -1} \frac{x^3 - 2x - 1}{x^4 + 2x + 1}.$$

$$d.28. \lim_{x \rightarrow 0} \frac{(1+x)^3 - (1+3x)}{x^2 + x^5}.$$

$$d.29. \lim_{x \rightarrow 1} \frac{x^2 - 1}{2x^2 - x - 1}.$$

$$d.30. \lim_{x \rightarrow -3} \frac{x^3 + 7x^2 + 15x + 9}{x^3 + 8x^2 + 21x + 18}.$$

**2.2. (е) Функции с радикалами:**

$$e.1 \lim_{x \rightarrow 4} \frac{\sqrt{1+2x} - 3}{\sqrt{x} - 2}.$$

$$e.2 \lim_{x \rightarrow -8} \frac{\sqrt{1-x} - 3}{2 + \sqrt[3]{x}}.$$

$$e.3 \lim_{x \rightarrow 1} \frac{\sqrt{x-1}}{\sqrt[3]{x^2-1}}.$$

$$e.4 \lim_{x \rightarrow 3} \frac{\sqrt{x+13} - 2\sqrt{x+1}}{x^2 - 9}.$$

$$e.5 \lim_{x \rightarrow -2} \frac{\sqrt[3]{x-6} + 2}{x^3 + 8}.$$

$$e.6 \lim_{x \rightarrow 16} \frac{\sqrt[4]{x} - 2}{\sqrt{x} - 4}.$$

$$e.7 \lim_{x \rightarrow 8} \frac{\sqrt{9+2x} - 5}{\sqrt[3]{x} - 2}.$$

$$e.8 \lim_{x \rightarrow 0} \frac{\sqrt{1-2x+x^2} - (1+x)}{x}.$$

$$e.9 \lim_{x \rightarrow 0} \frac{\sqrt[3]{8+3x+x^2} - 2}{x+x^2}.$$

$$e.10 \lim_{x \rightarrow 0} \frac{\sqrt[3]{27+x} - \sqrt[3]{27-x}}{x+2\sqrt[3]{x^4}}.$$

$$e.11 \lim_{x \rightarrow 1} \frac{\sqrt[3]{x} - 1}{\sqrt{1+x} - \sqrt{2x}}.$$

$$e.12 \lim_{x \rightarrow 0} \frac{\sqrt{1+x} - \sqrt{1-x}}{\sqrt[3]{1+x} - \sqrt[3]{1-x}}.$$

$$e.13 \lim_{x \rightarrow 2} \frac{\sqrt[3]{4x} - 2}{\sqrt{2+x} - \sqrt{2x}}.$$

$$e.14 \lim_{x \rightarrow 1} \frac{\sqrt{x} - 1}{x^2 - 1}.$$

$$e.15 \lim_{x \rightarrow 3} \frac{\sqrt[3]{9x} - 3}{\sqrt{3+x} - \sqrt{2x}}.$$

$$e.16 \lim_{x \rightarrow -2} \frac{\sqrt[3]{x-6} + 2}{x+2}.$$

$$e.17 \lim_{x \rightarrow 4} \frac{\sqrt[3]{16x} - 4}{\sqrt{4+x} - \sqrt{2x}}.$$

$$e.18 \lim_{x \rightarrow 8} \frac{\sqrt{9+2x} - 5}{\sqrt[3]{x^2} - 4}.$$

$$e.19 \lim_{x \rightarrow 1/2} \frac{\sqrt[3]{x/4} - 1/2}{\sqrt{1/2+x} - \sqrt{2x}}.$$

$$e.20 \lim_{x \rightarrow 1/3} \frac{\sqrt[3]{x/9} - 1/3}{\sqrt{1/3+x} - \sqrt{2x}}.$$

$$e.21 \lim_{x \rightarrow 1/4} \frac{\sqrt[3]{x/16} - 1/4}{\sqrt{1/4+x} - \sqrt{2x}}.$$

$$e.22 \lim_{x \rightarrow 0} \frac{\sqrt{1+x} - \sqrt{1-x}}{\sqrt[7]{x}}.$$



$$e.23 \lim_{x \rightarrow 0} \frac{\sqrt[3]{27+x} - \sqrt[3]{27-x}}{\sqrt[3]{x^2} + \sqrt[5]{x}}.$$

$$e.24 \lim_{x \rightarrow 0} \frac{\sqrt[3]{8+3x-x^2} - 2}{\sqrt[3]{x^2+x^3}}.$$

$$e.25 \lim_{x \rightarrow 0} \frac{\sqrt{1-2x+3x^2} - (1+x)}{\sqrt[3]{x}}.$$

$$e.26 \lim_{x \rightarrow 8} \frac{\sqrt{9+2x} - 5}{\sqrt[3]{x} - 2}.$$

$$e.27 \lim_{x \rightarrow 16} \frac{\sqrt[4]{x} - 2}{\sqrt[3]{(\sqrt{x} - 4)^2}}.$$

$$e.28 \lim_{x \rightarrow -2} \frac{\sqrt[3]{x-6} + 2}{\sqrt[3]{x^3+8}}.$$

$$e.29 \lim_{x \rightarrow 4} \frac{\sqrt{x} - 2}{\sqrt[3]{x^2-16}}.$$

$$e.30 \lim_{x \rightarrow -8} \frac{10-x-6\sqrt{1-x}}{2+\sqrt[3]{x}}.$$

## 2.2. (f) Сложные функции:

$$f.1. \lim_{x \rightarrow 0} \frac{\ln(1+\sin x)}{\sin 4x}.$$

$$f.2. \lim_{x \rightarrow 0} \frac{1-\cos 10x}{e^{x^2}-1}.$$

$$f.3 \lim_{x \rightarrow 0} \frac{3x^2-5x}{\sin 3x}.$$

$$f.4 \lim_{x \rightarrow 0} \frac{1-\cos 2x}{\cos 7x - \cos 3x}.$$

$$f.5 \lim_{x \rightarrow 0} \frac{4x}{\operatorname{tg}(\pi(2+x))}.$$

$$f.6 \lim_{x \rightarrow 0} \frac{2x}{\operatorname{tg}[2\pi(x+1/2)]}.$$

$$f.7 \lim_{x \rightarrow 0} \frac{1-\cos^3 x}{4x^2}.$$

$$f.8 \lim_{x \rightarrow 0} \frac{\arcsin 3x}{\sqrt{2+x}-\sqrt{2}}.$$

$$f.9 \lim_{x \rightarrow 0} \frac{2^x-1}{\ln(1+2x)}.$$

$$f.10 \lim_{x \rightarrow 0} \frac{\operatorname{arctg} 2x}{\sin(2\pi(x+10))}.$$

$$f.11 \lim_{x \rightarrow 0} \frac{\ln(1-7x)}{\sin(\pi(x+7))}.$$

$$f.12 \lim_{x \rightarrow 0} \frac{\cos(x+5\pi/2)\operatorname{tg} x}{\arcsin 2x^2}.$$

$$f.13 \lim_{x \rightarrow 0} \frac{9\ln(1-2x)}{4\operatorname{arctg} 3x}.$$

$$f.14 \lim_{x \rightarrow 0} \frac{1-\sqrt{3x+1}}{\cos[\pi(x+1)/2]}.$$

$$\text{f.15 } \lim_{x \rightarrow 0} \frac{\sin 7x}{x^2 + \pi x}.$$

$$\text{f.16 } \lim_{x \rightarrow 0} \frac{\sqrt{4+x} - 2}{3 \arctg x}.$$

$$\text{f.17 } \lim_{x \rightarrow 0} \frac{2 \sin[\pi(x+1)]}{\ln(1+2x)}.$$

$$\text{f.18 } \lim_{x \rightarrow 0} \frac{\cos 2x - \cos x}{1 - \cos x}.$$

$$\text{f.19 } \lim_{x \rightarrow 0} \frac{\sqrt{1+x} - 1}{\sin[\pi(x+2)]}.$$

$$\text{f.20 } \lim_{x \rightarrow 0} \frac{\sin[5(x+\pi)]}{e^{3x} - 1}.$$

$$\text{f.21 } \lim_{x \rightarrow 0} \frac{1 - \sqrt{\cos x}}{x \sin x}.$$

$$\text{f.22 } \lim_{x \rightarrow 0} \frac{\arcsin 2x}{2^{-3x} - 1} \ln 2.$$

$$\text{f.23 } \lim_{x \rightarrow 0} \frac{e^{4x} - 1}{\sin(\pi(x/2 + 1))}.$$

$$\text{f.24 } \lim_{x \rightarrow 0} \frac{1 - \cos x}{(e^{3x} - 1)^2}.$$

$$\text{f.25 } \lim_{x \rightarrow 0} \frac{\sin^2 x - \text{tg}^2 x}{x^4}.$$

$$\text{f.26 } \lim_{x \rightarrow 0} \frac{\arcsin 2x}{\ln(e-x) - 1}.$$

$$\text{f.27 } \lim_{x \rightarrow 0} \frac{\text{tg} x - \sin x}{x(1 - \cos 2x)}.$$

$$\text{f.28 } \lim_{x \rightarrow 0} \frac{\ln(x^2 + 1)}{1 - \sqrt{x^2 + 1}}.$$

$$\text{f.29 } \lim_{x \rightarrow 0} \frac{\text{tg}(\pi(1+x/2))}{\ln(x+1)}.$$

$$\text{f.30 } \lim_{x \rightarrow 0} \frac{2(e^{\pi x} - 1)}{3(\sqrt[3]{1+x} - 1)}.$$

## 2.3. Вычислить производные функций

### 2.3. (g) Степенные функции:

$$\text{g.1. } y = \frac{2(3x^3 + 4x^2 - x - 2)}{15\sqrt{1+x}}.$$

$$\text{g.2. } y = \frac{(2x^2 - 1)\sqrt{1+x^2}}{3x^3}.$$

$$\text{g.3. } y = \frac{x^4 - 8x^2}{2(x^2 - 4)}.$$

$$\text{g.4. } y = \frac{2x^2 - x - 1}{3\sqrt{2+4x}}.$$

$$\text{g.5. } y = \frac{(1+x^8)\sqrt{1+x^8}}{12x^{12}}.$$

$$\text{g.6. } y = \frac{x^2}{2\sqrt{1-3x^4}}.$$

$$\text{g.7. } y = \frac{(x^2-6)\sqrt{(4+x^2)^3}}{120x^5}.$$

$$\text{g.8. } y = \frac{(x^2-8)\sqrt{x^2-8}}{6x^3}.$$

$$\text{g.9. } y = \frac{4+3x^3}{x^3\sqrt{(2+x^3)^2}}.$$

$$\text{g.10. } y = \sqrt[3]{\frac{(1+x^{3/4})^2}{x^{3/2}}}.$$

$$\text{g.11. } y = \frac{x^6+x^3-2}{\sqrt{1-x^3}}.$$

$$\text{g.12. } y = \frac{(x^2-2)\sqrt{4+x^2}}{24x^3}.$$

$$\text{g.13. } y = \frac{1+x^2}{2\sqrt{1+2x^2}}.$$

$$\text{g.14. } y = \frac{\sqrt{x-1}(3x+2)}{4x^2}.$$

$$\text{g.15. } y = \frac{\sqrt{(1+x^2)^3}}{3x^3}.$$

$$\text{g.16. } y = \frac{x^6+8x^3-128}{\sqrt{8-x^3}}.$$

$$\text{g.17. } y = \frac{\sqrt{2x+3}(x-2)}{x^2}.$$

$$\text{g.18. } y = (1-x^2)^5\sqrt{x^3+\frac{1}{x}}.$$

$$\text{g.19. } y = \frac{(2x^2+3)\sqrt{x^2-3}}{9x^3}.$$

$$\text{g.20. } y = \frac{x-1}{(x^2+5)\sqrt{x^2+5}}.$$

$$\text{g.21. } y = \frac{(2x+1)\sqrt{x^2-x}}{x^2}.$$

$$\text{g.22. } y = 2\sqrt{\frac{1-\sqrt{x}}{1+\sqrt{x}}}.$$

$$\text{g.23. } y = \frac{1}{(x+2)\sqrt{x^2+4x+5}}.$$

$$\text{g.24. } y = 3\frac{\sqrt[3]{x^2+x+1}}{x+1}.$$

$$g.25. y = 3 \cdot \sqrt[3]{\frac{(x+1)}{(x-1)^2}}$$

$$g.26. y = \frac{x+7}{6\sqrt{x^2+2x+7}}$$

$$g.27. y = \frac{x\sqrt{x+1}}{x^2+x+1}$$

$$g.28. y = \frac{x^2+2}{2\sqrt{1-x^4}}$$

$$g.29. y = \frac{(x+3)\sqrt{2x-1}}{2x+7}$$

$$g.30. y = \frac{3x+\sqrt{x}}{\sqrt{x^2+2}}$$

### 2.3. (h) Тригонометрические функции:

$$h.1. y = \sin\sqrt{3} + \frac{1 \sin^2 3x}{3 \cos 6x}$$

$$h.2. y = \cos \ln 2 - \frac{1 \cos^2 3x}{3 \sin 6x}$$

$$h.3. y = \operatorname{tg} \lg \frac{1}{3} + \frac{1 \sin^2 4x}{4 \cos 8x}$$

$$h.4. y = \operatorname{ctg} \sqrt[3]{5} - \frac{1 \cos^2 4x}{8 \sin 8x}$$

$$h.5. y = \frac{\cos \sin 5 \cdot \sin^2 2x}{2 \cos 4x}$$

$$h.6. y = \frac{\sin \cos 3 \cdot \cos^2 2x}{4 \sin 4x}$$

$$h.7. y = \frac{\cos \ln 7 \cdot \sin^2 7x}{7 \cos 14x}$$

$$h.8. y = \cos(\operatorname{ctg} 2) - \frac{1 \cos^2 8x}{16 \sin 16x}$$

$$h.9. y = \operatorname{ctg}(\cos 2) + \frac{1 \sin^2 6x}{6 \cos 12x}$$

$$h.10. y = \sqrt[3]{\operatorname{ctg} 2} - \frac{1 \cos^2 10x}{20 \sin 20x}$$

$$h.11. y = \frac{1}{3} \cos\left(\operatorname{tg} \frac{1}{2}\right) + \frac{1 \sin^2 10x}{10 \cos 20x}$$

$$h.12. y = \ln \sin \frac{1}{2} - \frac{1 \cos^2 12x}{24 \sin 24x}$$

$$h.13. y = 8 \sin(\operatorname{ctg} 3) + \frac{1 \sin^2 5x}{5 \cos 10x}$$

$$h.14. y = \frac{\cos(\operatorname{ctg} 3) \cdot \cos^2 14x}{28 \sin 28x}$$

$$h.15. y = \frac{\cos\left(\operatorname{tg} \frac{1}{3}\right) \cdot \sin^2 15x}{15 \cos 30x}$$

$$h.16. y = \frac{\sin\left(\operatorname{tg} \frac{1}{7}\right) \cdot \cos^2 16x}{32 \sin 32x}$$

$$\text{h.17. } y = \frac{\operatorname{ctg}\left(\sin\frac{1}{3}\right) \cdot \sin^2 17x}{17 \cos 34x}.$$

$$\text{h.18. } y = \frac{\sqrt[5]{\operatorname{ctg} 2} \cdot \cos^2 18x}{36 \sin 36x}.$$

$$\text{h.19. } y = \frac{\operatorname{tg}(\ln 2) \cdot \sin^2 19x}{19 \cos 38x}.$$

$$\text{h.20. } y = \operatorname{ctg}(\cos 5) - \frac{1}{40} \frac{\cos^2 20x}{\sin 40x}.$$

$$\text{h.21. } y = \sqrt{\operatorname{tg} 4} + \frac{\sin^2 21x}{21 \cos 42x}.$$

$$\text{h.22. } y = \cos(\ln 13) - \frac{1}{44} \frac{\cos^2 22x}{\sin 44x}.$$

$$\text{h.23. } y = \ln \cos \frac{1}{3} + \frac{\sin^2 23x}{23 \cos 46x}.$$

$$\text{h.24. } y = \operatorname{ctg}\left(\sin\frac{1}{13}\right) - \frac{1}{48} \frac{\cos^2 24x}{\sin 48x}.$$

$$\text{h.25. } y = \sin \ln 2 + \frac{\sin^2 25x}{25 \cos 50x}.$$

$$\text{h.26. } y = \sqrt[3]{\cos \sqrt{2}} - \frac{1}{52} \frac{\cos^2 26x}{\sin 52x}.$$

$$\text{h.27. } y = \sqrt[7]{\operatorname{tg}(\cos 2)} + \frac{\sin^2 27x}{27 \cos 54x}.$$

$$\text{h.28. } y = \sin \sqrt[3]{\operatorname{tg} 2} - \frac{\cos^2 28x}{56 \sin 56x}.$$

$$\text{h.29. } y = \cos^2 \sin 3 + \frac{\sin^2 29x}{29 \cos 58x}.$$

$$\text{h.30. } y = \sin^3 \cos 2 - \frac{\cos^2 30x}{60 \sin 60x}.$$

**2.3. (i) Найти производную n-го порядка:**

$$\text{i.1. } y = x e^{ax}.$$

$$\text{i.2. } y = \sin 2x + \cos(x+1).$$

$$\text{i.3. } y = \sqrt[5]{e^{7x-1}}.$$

$$\text{i.4. } y = \frac{4x+7}{2x+3}.$$

$$\text{i.5. } y = \lg(5x+2).$$

$$\text{i.6. } y = a^{3x}.$$

$$\text{i.7. } y = \frac{x}{2(3x+2)}.$$

$$\text{i.8. } y = \lg(x+4).$$

$$\text{i.9. } y = \sqrt{x}.$$

$$\text{i.10. } y = \frac{2x+5}{13(3x+1)}.$$

$$i.11. y = 2^{3x+5}.$$

$$i.12. y = \sin(x+1) + \cos 2x.$$

$$i.13. y = \sqrt[3]{e^{2x+1}}.$$

$$i.14. y = \frac{4+15x}{5x+1}.$$

$$i.15. y = \lg(3x+1).$$

$$i.16. y = 7^{5x}.$$

$$i.17. y = \frac{x}{9(4x+9)}.$$

$$i.18. y = \lg(1+x).$$

$$i.19. y = \frac{4}{x}.$$

$$i.20. y = \frac{5x+1}{13(2x+3)}.$$

$$i.21. y = a^{2x+3}.$$

$$i.22. y = \sin(3x+1) + \cos 5x.$$

$$i.23. y = \sqrt{e^{3x+1}}.$$

$$i.24. y = \frac{11+12x}{6x+5}.$$

$$i.25. y = \lg(2x+7).$$

$$i.26. y = 2^{kx}.$$

$$i.27. y = \frac{x}{x+1}.$$

$$i.28. y = \log_3(x+5).$$

$$i.29. y = \frac{1+x}{1-x}.$$

$$i.30. y = \frac{7x+1}{17(4x+3)}.$$

## 2.4. Вычислить интегралы

### 2.4. (j) Неопределённые интегралы:

$$j.1. \int (4-3x)e^{-3x} dx.$$

$$j.2. \int \operatorname{arctg} \sqrt{4x-1} dx.$$

$$j.3. \int (3x+4)e^{3x} dx.$$

$$j.4. \int (4x-2)\cos 2x dx.$$

$$j.5. \int (4-16x)\sin 4x dx.$$

$$j.6. \int (5x-2)e^{3x} dx.$$

$$j.7. \int (1-6x)e^{2x} dx.$$

$$j.8. \int \ln(x^2+4) dx.$$

$$j.9. \int \ln(4x^2 + 1) dx.$$

$$j.10. \int (2 - 4x) \sin 2x dx.$$

$$j.11. \int \operatorname{arctg} \sqrt{6x - 1} dx.$$

$$j.12. \int e^{-2x} (4x - 3) dx.$$

$$j.13. \int e^{-3x} (2 - 9x) dx.$$

$$j.14. \int \operatorname{arctg} \sqrt{2x - 1} dx.$$

$$j.15. \int \operatorname{arctg} \sqrt{3x - 1} dx.$$

$$j.16. \int \operatorname{arctg} \sqrt{5x - 1} dx.$$

$$j.17. \int (5x + 6) \cos 2x dx.$$

$$j.18. \int (3x - 2) \cos 5x dx.$$

$$j.19. \int (x\sqrt{2} - 3) \cos 2x dx.$$

$$j.20. \int (4x + 7) \cos 3x dx.$$

$$j.21. \int (2x - 5) \cos 4x dx.$$

$$j.22. \int (8 - 3x) \cos 5x dx.$$

$$j.23. \int (x + 5) \sin 3x dx.$$

$$j.24. \int (2 - 3x) \sin 2x dx.$$

$$j.25. \int (4x + 3) \sin 5x dx.$$

$$j.26. \int (7x - 10) \sin 4x dx.$$

$$j.27. \int (\sqrt{2} - 8x) \sin 3x dx.$$

$$j.28. \int \frac{xdx}{\cos^2 x}.$$

$$j.29. \int \frac{xdx}{\sin^2 x}.$$

$$j.30. \int x \sin^2 x dx.$$

#### 2.4. (k) Определённые интегралы:

$$k.1. \int_{e+1}^{e^2+1} \frac{1 + \ln(x-1)}{x-1} dx.$$

$$k.2. \int_0^1 \frac{(x^2 + 1) dx}{(x^3 + 3x + 1)^2}.$$

$$k.3. \int_0^1 \frac{4 \operatorname{arctg} x - x}{1 + x^2} dx.$$

$$k.4. \int_0^2 \frac{x^3 dx}{x^2 + 4}.$$

$$k.5. \int_{\pi}^{2\pi} \frac{x + \cos x}{x^2 + 2 \sin x} dx.$$

$$k.6. \int_0^{\pi/4} \frac{2 \cos x + 3 \sin x}{(2 \sin x - 3 \cos x)^3} dx.$$

$$\text{k.7. } \int_0^{1/2} \frac{8x - \operatorname{arctg} 2x}{1 + 4x^2} dx.$$

$$\text{k.8. } \int_1^4 \frac{1/(2\sqrt{x}) + 1}{(\sqrt{x} + x)^2} dx.$$

$$\text{k.9. } \int_0^1 \frac{x dx}{x^4 + 1}.$$

$$\text{k.10. } \int_{\sqrt{3}}^{\sqrt{8}} \frac{x + 1/x}{\sqrt{x^2 + 1}} dx.$$

$$\text{k.11. } \int_{\sqrt{3}}^{\sqrt{8}} \frac{x - 1/x}{\sqrt{x^2 + 1}} dx.$$

$$\text{k.12. } \int_0^{\sqrt{3}} \frac{\operatorname{arctg} x + x}{1 + x^2} dx.$$

$$\text{k.13. } \int_0^{\sqrt{3}} \frac{x - (\operatorname{arctg} x)^4}{1 + x^2} dx.$$

$$\text{k.14. } \int_0^1 \frac{x^3}{x^2 + 1} dx.$$

$$\text{k.15. } \int_0^{\sin 1} \frac{(\arcsin x)^2 + 1}{\sqrt{1 - x^2}} dx.$$

$$\text{k.16. } \int_1^3 \frac{1 - \sqrt{x}}{\sqrt{x}(x + 1)} dx.$$

$$\text{k.17. } \int_{\sqrt{3}}^{\sqrt{8}} \frac{dx}{x\sqrt{x^2 + 1}}.$$

$$\text{k.18. } \int_1^e \frac{1 + \ln x}{x} dx.$$

$$\text{k.19. } \int_{\sqrt{2}}^2 \frac{dx}{x\sqrt{x^2 - 1}}.$$

$$\text{k.20. } \int_1^e \frac{x^2 + \ln x^2}{x} dx.$$

$$\text{k.21. } \int_0^1 \frac{x dx}{\sqrt{x^4 + x^2 + 1}}.$$

$$\text{k.22. } \int_0^1 \frac{x^3 dx}{(x^2 + 1)^2}.$$

$$\text{k.23. } \int_0^{\pi/4} \operatorname{tg} x \ln \cos x dx.$$

$$\text{k.24. } \int_{-1}^0 \frac{\operatorname{tg}(x + 1)}{\cos^2(x + 1)} dx.$$

$$\text{k.25. } \int_0^{1/\sqrt{2}} \frac{(\arccos x)^3 - 1}{\sqrt{1 - x^2}} dx.$$

$$\text{k.26. } \int_{\pi}^{2\pi} \frac{1 - \cos x}{(x - \sin x)^2} dx.$$

$$\text{k.27. } \int_0^{\pi/4} \frac{\sin x - \cos x}{(\cos x + \sin x)^5} dx.$$

$$\text{k.28. } \int_{\pi/4}^{\pi/2} \frac{x \cos x + \sin x}{(x \sin x)^2} dx.$$



$$\text{k.29. } \int_0^1 \frac{x^3 + x}{x^4 + 1} dx.$$

$$\text{k.30. } \int_{\sqrt{2}}^{\sqrt{3}} \frac{x dx}{\sqrt{x^4 - x^2 - 1}}.$$

## 2.5. Исследовать функции и построить их графики

### 2.5. (I) Рациональные функции:

$$1.1. y = (x^3 + 4)/x^2.$$

$$1.2. y = (x^2 - x + 1)/(x - 1).$$

$$1.3. y = 2/(x^2 + 2x).$$

$$1.4. y = 4x^2/(3 + x^2).$$

$$1.5. y = 12x/(9 + x^2).$$

$$1.6. y = (x^2 - 3x + 3)/(x - 1).$$

$$1.7. y = (4 - x^3)/x^2.$$

$$1.8. y = (x^2 - 4x + 1)/(x - 4).$$

$$1.9. y = (2x^3 + 1)/x^2.$$

$$1.10. y = (x - 1)^2/x^2.$$

$$1.11. y = x^2/(x - 1)^2.$$

$$1.12. y = (1 + 1/x)^2.$$

$$1.13. y = (12 - 3x^2)/(x^2 + 12).$$

$$1.14. y = (9 + 6x - 3x^2)/(x^2 - 2x + 13).$$

$$1.15. y = -8x/(x^2 + 4).$$

$$1.16. y = ((x - 1)/(x + 1))^2.$$

$$1.17. y = (3x^4 + 1)/x^3.$$

$$1.18. y = 4x/(x + 1)^2.$$

$$1.19. y = 8(x - 1)/(x + 1)^2.$$

$$1.20. y = (1 - 2x^3)/x^2.$$

$$1.21. y = 4/(x^2 + 2x - 3).$$

$$1.22. y = 4/(3 + 2x - x^2).$$

$$1.23. y = (x^2 + 2x - 7)/(x^2 + 2x - 3).$$

$$1.24. y = 1/(x^4 - 1).$$

$$1.25. y = -(x/(x + 2))^2.$$

$$1.26. y = (x^3 - 32)/x^2.$$

$$1.27. y = 4(x + 1)^2/(x^2 + 2x + 4).$$

$$1.28. y = (3x - 2)/x^3.$$

$$1.29. y = (x^2 - 6x + 9)/(x-1)^2.$$

$$1.30. y = (x^3 - 27x + 54)/x^3.$$

**2.5. (m) Функции с радикалами:**

$$m.1. y = \sqrt[3]{(2-x)(x^2-4x+1)}.$$

$$m.2. y = -\sqrt[3]{(x+3)(x^2+6x+6)}.$$

$$m.3. y = \sqrt[3]{(x+2)(x^2+4x+1)}.$$

$$m.4. y = \sqrt[3]{(x+1)(x^2+2x-2)}.$$

$$m.5. y = \sqrt[3]{(x-1)(x^2-2x-2)}.$$

$$m.6. y = \sqrt[3]{(x-3)(x^2-6x+6)}.$$

$$m.7. y = \sqrt[3]{(x^2-4x+3)^2}.$$

$$m.8. y = \sqrt[3]{x^2(x+2)^2}.$$

$$m.9. y = \sqrt[3]{x^2(x-2)^2}.$$

$$m.10. y = \sqrt[3]{(x^2-2x-3)^2}.$$

$$m.11. y = \sqrt[3]{x^2(x+4)^2}.$$

$$m.12. y = \sqrt[3]{x^2(x-4)^2}.$$

$$m.13. y = \sqrt[3]{(x+3)x^2}.$$

$$m.14. y = \sqrt[3]{(x-1)(x+2)^2}.$$

$$m.15. y = \sqrt[3]{(x-1)^2} - \sqrt[3]{x^2}.$$

$$m.16. y = \sqrt[3]{(x+6)x^2}.$$

$$m.17. y = \sqrt[3]{(x-4)(x+2)^2}.$$

$$m.18. y = \sqrt[3]{(x-1)^2} - \sqrt[3]{(x-2)^2}.$$

$$m.19. y = \sqrt[3]{(x+1)(x-2)^2}.$$

$$m.20. y = \sqrt[3]{(x-3)x^2}.$$

$$m.21. y = \sqrt[3]{(x-2)^2} - \sqrt[3]{(x-3)^2}.$$

$$m.22. y = \sqrt[3]{(x+2)(x-4)^2}.$$

$$m.23. y = \sqrt[3]{(x-6)x^2}.$$

$$m.24. y = \sqrt[3]{x^2} - \sqrt[3]{(x-1)^2}.$$

$$m.25. y = \sqrt[3]{x(x-3)^2}.$$

$$m.26. y = \sqrt[3]{x(x+3)^2}.$$

$$m.27. y = \sqrt[3]{(x+2)^2} - \sqrt[3]{(x+3)^2}.$$

$$m.28. y = \sqrt[3]{x(x-6)^2}.$$

$$m.29. y = \sqrt[3]{x(x+6)^2}.$$

$$m.30. y = \sqrt[3]{(x+1)^2} - \sqrt[3]{(x+2)^2}.$$

**2.5. (n) Сложные функции:**

$$n.1. y = e^{\sin x + \cos x}.$$

$$n.2. y = \operatorname{arctg} \left[ (\sin x + \cos x) / \sqrt{2} \right].$$

$$n.3. y = \ln(\sin x + \cos x).$$

$$n.4. y = 1/(\sin x + \cos x).$$

$$n.5. y = e^{\sqrt{2} \sin x}.$$

$$n.6. y = \operatorname{arctg}(\sin x).$$

$$n.7. y = \ln(\sqrt{2} \sin x).$$

$$n.8. y = 1/(\sin x - \cos x).$$

$$n.9. y = e^{\sin x - \cos x}.$$

$$n.10. y = \operatorname{arctg} \left[ (\sin x - \cos x) / \sqrt{2} \right].$$

$$n.11. y = \ln(\sin x - \cos x).$$

$$n.12. y = 1/(\sin x + \cos x)^2.$$

$$n.13. y = e^{-\sqrt{2} \cos x}.$$

$$n.14. y = -\operatorname{arctg}(\cos x).$$

$$n.15. y = \ln(-\sqrt{2} \cos x).$$

$$n.16. y = 1/(\sin x - \cos x)^2.$$

$$n.17. y = e^{-\sin x - \cos x}.$$

$$n.18. y = \sqrt[3]{\sin x}.$$

$$n.19. y = \ln(-\sin x - \cos x).$$

$$n.20. y = \sqrt{(\sin x - \cos x) / \sqrt{2}}.$$

$$n.21. y = e^{-\sqrt{2} \sin x}.$$

$$n.22. y = \sqrt[3]{\cos x}.$$

$$n.23. y = \ln(-\sqrt{2} \sin x).$$

$$n.24. y = \sqrt{\cos x}.$$

$$n.25. y = e^{\cos x - \sin x}.$$

$$n.26. y = \sqrt[3]{(\sin x + \cos x) / \sqrt{2}}.$$

$$n.27. y = \ln(\cos x - \sin x).$$

$$n.28. y = \sqrt{\sin x}.$$

$$n.29. y = e^{\sqrt{2} \cos x}.$$

$$n.30. y = \sqrt{(\sin x + \cos x) / \sqrt{2}}.$$

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