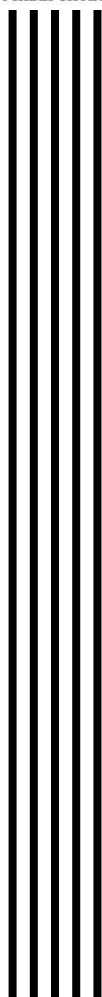


Министерство образования и науки, молодежи и спорта Украины
Севастопольский национальный технический университет



ПРЕДЕЛ. НЕПРЕРЫВНОСТЬ

Методические указания и контрольные задания
к практическим занятиям
по дисциплине «Высшая математика»
для студентов всех специальностей и форм обучения

Часть 2

Севастополь
2012

Предел. Непрерывность. Метод. указания и контрольные задания к практическим занятиям по дисциплине «Высшая математика» для студентов всех специальностей и форм обучения: в 2 ч. / Сост. Л.Н. Григорюк. – Севастополь: Изд-во СевНТУ, 2012. – Ч. 2. – 32 с.

Целью методических указаний является усвоение студентами основных теоретических сведений по теории пределов и привитие практических навыков при решении задач, связанных с вычислением пределов и исследованием функций на непрерывность.

Методические указания предназначены для студентов всех специальностей и форм обучения.

Методические указания рассмотрены и утверждены на заседании кафедры «Высшая математика» 07.12.2012 г., протокол № 4.

Допущено учебно-методическим центром и научно-методическим советом СевНТУ в качестве методических указаний.

Рецензент: Быкова В.П., старший преподаватель кафедры высшей математики

Задача 1. Доказать

1. $\lim_{n \rightarrow \infty} \frac{5n+1}{2n+2} = \frac{5}{2};$

3. $\lim_{n \rightarrow \infty} \frac{3n-1}{4n+1} = \frac{3}{4};$

5. $\lim_{n \rightarrow \infty} \frac{2n+4}{3n+1} = \frac{2}{3};$

7. $\lim_{n \rightarrow \infty} \frac{4n+2}{3n+1} = \frac{4}{3};$

9. $\lim_{n \rightarrow \infty} \frac{4n-3}{2n+3} = 2;$

11. $\lim_{n \rightarrow \infty} \frac{n+1}{1-2n} = -\frac{1}{2};$

13. $\lim_{n \rightarrow \infty} \frac{1-2n}{n+3} = -2;$

15. $\lim_{n \rightarrow \infty} \frac{n}{3n-1} = \frac{1}{3};$

17. $\lim_{n \rightarrow \infty} \frac{4+2n}{1-3n} = -\frac{2}{3};$

19. $\lim_{n \rightarrow \infty} \frac{3-n}{1+2n} = -\frac{1}{2};$

21. $\lim_{n \rightarrow \infty} \frac{2n+1}{4+n} = 2;$

23. $\lim_{n \rightarrow \infty} \frac{3n+2}{4n+1} = \frac{3}{4};$

25. $\lim_{n \rightarrow \infty} \frac{2n+3}{4n-1} = \frac{1}{2};$

27. $\lim_{n \rightarrow \infty} \frac{n+1}{3n-2} = \frac{1}{3};$

29. $\lim_{n \rightarrow \infty} \frac{5n+1}{10n+3} = \frac{1}{2};$

2. $\lim_{n \rightarrow \infty} \frac{3n-2}{2n-1} = \frac{3}{2};$

4. $\lim_{n \rightarrow \infty} \frac{4n-1}{2n+1} = 2;$

6. $\lim_{n \rightarrow \infty} \frac{2n-5}{3n+1} = \frac{2}{3};$

8. $\lim_{n \rightarrow \infty} \frac{2-n}{1+2n} = -\frac{1}{2};$

10. $\lim_{n \rightarrow \infty} \frac{1-2n}{2+4n} = -\frac{1}{2};$

12. $\lim_{n \rightarrow \infty} \frac{2n+1}{3n-5} = \frac{2}{3};$

14. $\lim_{n \rightarrow \infty} \frac{3n+1}{2-n} = -3;$

16. $\lim_{n \rightarrow \infty} \frac{3n}{n-1} = 3;$

18. $\lim_{n \rightarrow \infty} \frac{2n+1}{5-n} = -2;$

20. $\lim_{n \rightarrow \infty} \frac{2n+1}{4-3n} = -\frac{2}{3};$

22. $\lim_{n \rightarrow \infty} \frac{3n+1}{2n+5} = \frac{3}{2};$

24. $\lim_{n \rightarrow \infty} \frac{4n-3}{2n+1} = 2;$

26. $\lim_{n \rightarrow \infty} \frac{1-3n}{2+4n} = -\frac{3}{4};$

28. $\lim_{n \rightarrow \infty} \frac{2-2n}{3+4n} = -\frac{1}{2};$

30. $\lim_{n \rightarrow \infty} \frac{1+3n}{2-n} = -3$

Задача 2. Найти предел функции

1. $\lim_{n \rightarrow \infty} \frac{n - 2n^3 + 5n^4}{2 + 3n^2 + n^4};$

2. $\lim_{n \rightarrow \infty} \frac{3n^2 - 4n + 2}{6n^2 + 5n + 1};$

3. $\lim_{n \rightarrow \infty} \frac{2n^3 + 7n - 2}{3n^3 - n - 4};$

4. $\lim_{n \rightarrow \infty} \frac{4 - 5n^2 - 3n^5}{n^5 + 6n + 8};$

5. $\lim_{n \rightarrow \infty} \frac{1 + 4n - n^4}{n + 3n^2 + 2n^4};$

6. $\lim_{n \rightarrow \infty} \frac{3n^4 - 6n^2 + 2}{n^4 + 4n - 3};$

7. $\lim_{n \rightarrow \infty} \frac{4n^3 - 2n + 1}{2n^3 + 3n^2 + 2};$

8. $\lim_{n \rightarrow \infty} \frac{3n + 14n^3}{1 + 2n + 7n^3};$

9. $\lim_{n \rightarrow \infty} \frac{8n^4 - 4n^2 + 3}{2n^4 + 1};$

10. $\lim_{n \rightarrow \infty} \frac{3n^2 + 10n + 3}{2n^2 + 5n - 3};$

11. $\lim_{n \rightarrow \infty} \frac{3n^4 - 2n^2 - 7}{4n^4 + 3n + 5};$

12. $\lim_{n \rightarrow \infty} \frac{7n^3 + n}{n^3 - 3n + 2};$

13. $\lim_{n \rightarrow \infty} \frac{2n^2 + 7n + 3}{5n^2 - n + 4};$

14. $\lim_{n \rightarrow \infty} \frac{5n^3 - 7n + 3}{2 + 2n - n^3};$

15. $\lim_{n \rightarrow \infty} \frac{2n^3 + 7n^2 + 3}{6n^3 - 4n + 3};$

16. $\lim_{n \rightarrow \infty} \frac{n^3 - 3n^2 + 10}{7n^3 + n + 1};$

17. $\lim_{n \rightarrow \infty} \frac{5n^2 - 3n + 1}{3n^2 + n - 5};$

18. $\lim_{n \rightarrow \infty} \frac{n^3 - 4n^2 + 28n}{5n^3 + 3n^2 + n - 1};$

19. $\lim_{n \rightarrow \infty} \frac{3n^4 + 2n + 1}{n^4 - n^3 + 2n};$

20. $\lim_{n \rightarrow \infty} \frac{4n^3 + 7n}{2n^3 - 4n + 5};$

21. $\lim_{n \rightarrow \infty} \frac{n + n^2 - 3n^4}{n^4 + 3n - 2};$

22. $\lim_{n \rightarrow \infty} \frac{1 + 3n - n^2}{3n^2 + n - 5};$

23. $\lim_{n \rightarrow \infty} \frac{3n^2 + 5n - 7}{3n^2 + n + 1};$

24. $\lim_{n \rightarrow \infty} \frac{7n^3 - 2n^2 + 4n}{2n^3 + 5};$

25. $\lim_{n \rightarrow \infty} \frac{18n^2 + 5n}{8 - 3n - 9n^2};$

26. $\lim_{n \rightarrow \infty} \frac{3n^3 - 5n^2 + 2}{2n^3 + 5n^2 - n};$

27. $\lim_{n \rightarrow \infty} \frac{4n^2 + 5n - 7}{2n^2 - n + 10};$

28. $\lim_{n \rightarrow \infty} \frac{8n^2 + 4n - 5}{4n^2 - 3n + 2};$

$$29. \lim_{n \rightarrow \infty} \frac{5n^4 - 3n^2 + 7}{n^4 + 2n^3 + 1};$$

$$30. \lim_{n \rightarrow \infty} \frac{3n^2 + 2n + 9}{2n^2 - n + 4}.$$

Задача 3. Вычислить пределы числовых последовательностей

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$24. \lim_{n \rightarrow \infty} \frac{(n+2)^4 - (n-2)^4}{(n+2)^4 + (n-2)^3};$$

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

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

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

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

$$29. \lim_{n \rightarrow \infty} \frac{(2n+1)^2 - (n+1)^2}{n^2 + n + 1};$$

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

Задача 4. Вычислить предел последовательности

$$1. \lim_{n \rightarrow \infty} n(\sqrt{n^2 + 1} - \sqrt{n^2 - 1});$$

$$2. \lim_{n \rightarrow \infty} n(\sqrt{n(n-2)} - \sqrt{n^2 - 3});$$

$$3. \lim_{n \rightarrow \infty} (-\sqrt[3]{n^3 - 5} - \sqrt{n});$$

$$4. \lim_{n \rightarrow \infty} (\sqrt{n^2 + 1} - \sqrt{n^2 - 4} - \sqrt{n^4 - 9});$$

$$5. \lim_{n \rightarrow \infty} (\sqrt{n^2 + 2} - \sqrt{n^2 + 1} - \sqrt{n^2 - 1} + \sqrt{n^2 + 3});$$

$$6. \lim_{n \rightarrow \infty} (\sqrt{n^2 - 3n + 2} - n);$$

$$7. \lim_{n \rightarrow \infty} (\sqrt[3]{4 - n^3});$$

$$8. \lim_{n \rightarrow \infty} (\sqrt{n^2 + 2} - \sqrt{n^2 - 2n + 3});$$

$$9. \lim_{n \rightarrow \infty} (\sqrt{n^2 + 3} - \sqrt{n^2 + 2} - \sqrt{n^2 - 2} + \sqrt{n^2 + 5});$$

$$10. \lim_{n \rightarrow \infty} (\sqrt{n(n^4 - 1)} - \sqrt{n^5 - 8} - n^2);$$

11. $\lim_{n \rightarrow \infty} n \sqrt{5 + 8n^3} - 2n$;
12. $\lim_{n \rightarrow \infty} n^2 \left(\sqrt{5 + n^3} - \sqrt[3]{n^3 + 3} \right)$;
13. $\lim_{n \rightarrow \infty} n \left(\sqrt[3]{(n+2)^2} - \sqrt[3]{n-3} \right)$;
14. $\lim_{n \rightarrow \infty} \frac{\sqrt{n+1} - \sqrt{n(n-1)(n-3)}}{\sqrt{n}}$;
15. $\lim_{n \rightarrow \infty} \left(\sqrt{n^2 + 3} - \sqrt{n^2 - 3} \right)$;
16. $\lim_{n \rightarrow \infty} \sqrt{n} \left(\sqrt{n+2} - \sqrt{n-3} \right)$;
17. $\lim_{n \rightarrow \infty} n \left(\sqrt{n+1} - \sqrt{n-2} \right)$;
18. $\lim_{n \rightarrow \infty} \left(\sqrt{n+5} - n \right)$;
19. $\lim_{n \rightarrow \infty} \sqrt{n^3 + 8} \left(\sqrt{n^3 + 2} - \sqrt{n^3 - 1} \right)$;
20. $\lim_{n \rightarrow \infty} \left(\sqrt{n^3 + n + 1} - \sqrt{n^2 - 2} \right)$;
21. $\lim_{n \rightarrow \infty} \left(-\sqrt{n(n-4)} \right)$;
22. $\lim_{n \rightarrow \infty} \sqrt{n+1} \left(\sqrt{n+3} - \sqrt{n-1} \right)$;
23. $\lim_{n \rightarrow \infty} \left(\sqrt{n+2} - n \right)$;
24. $\lim_{n \rightarrow \infty} \left(-\sqrt{n(n-1)} \right)$;
25. $\lim_{n \rightarrow \infty} \left(\sqrt{n+5} \left(\sqrt{n+2} - \sqrt{n-1} \right) \right)$;
26. $\lim_{n \rightarrow \infty} \left(\sqrt{n} - \sqrt{n(n+1)(n+2)} \right)$;
27. $\lim_{n \rightarrow \infty} \sqrt[3]{n} \left(\sqrt{n^2} - \sqrt[3]{n(n-1)} \right)$;

$$28. \lim_{n \rightarrow \infty} \sqrt[n]{n+3} (\sqrt{n+1} - \sqrt{n-2}) ;$$

$$29. \lim_{n \rightarrow \infty} n (\sqrt{n^4+3} - \sqrt{n^4-2}) ;$$

$$30. \lim_{n \rightarrow \infty} (\sqrt{n^3+2} - \sqrt{n^3-1}) .$$

Задача 5. Вычислить пределы числовых последовательностей

$$1. \lim_{n \rightarrow \infty} \left(\frac{n+3}{n+5} \right)^{n+4} ;$$

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

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

$$4. \lim_{n \rightarrow \infty} \left(\frac{2n+3}{2n+1} \right)^{n+1} ;$$

$$5. \lim_{n \rightarrow \infty} \left(\frac{6n-7}{6n+4} \right)^{3n+2} ;$$

$$6. \lim_{n \rightarrow \infty} \left(\frac{n+3}{n+1} \right)^n ;$$

$$7. \lim_{n \rightarrow \infty} \left(\frac{n+4}{n+2} \right)^{3n} ;$$

$$8. \lim_{n \rightarrow \infty} \left(\frac{2n-1}{2n+1} \right)^{n+1} ;$$

$$9. \lim_{n \rightarrow \infty} \left(\frac{2n+3}{2n+4} \right)^{n+2} ;$$

$$10. \lim_{n \rightarrow \infty} \left(\frac{n-1}{n+3} \right)^{n+2} ;$$

$$11. \lim_{n \rightarrow \infty} \left(\frac{2n^2+2}{2n^2+1} \right)^{n^2} ;$$

$$12. \lim_{n \rightarrow \infty} \left(\frac{n+3}{n+5} \right)^{2n} ;$$

$$13. \lim_{n \rightarrow \infty} \left(\frac{13n+3}{13n-10} \right)^{n-3} ;$$

$$14. \lim_{n \rightarrow \infty} \left(\frac{n+5}{n-7} \right)^{\frac{n}{6}+1} ;$$

$$15. \lim_{n \rightarrow \infty} \left(\frac{2n+3}{2n+1} \right)^{n+1} ;$$

$$16. \lim_{n \rightarrow \infty} \left(\frac{n-10}{n+1} \right)^{3n+1} ;$$

$$17. \lim_{n \rightarrow \infty} \left(\frac{n-1}{n+1} \right)^{n^2} ;$$

$$18. \lim_{n \rightarrow \infty} \left(\frac{3n+1}{3n-1} \right)^{2n+3} ;$$

$$19. \lim_{n \rightarrow \infty} \left(\frac{10n-3}{10n-1} \right)^{5n};$$

$$21. \lim_{n \rightarrow \infty} \left(\frac{4n-1}{4n+3} \right)^{2n};$$

$$23. \lim_{n \rightarrow \infty} \left(\frac{n^2+6}{n^2+7} \right)^{n^2};$$

$$25. \lim_{n \rightarrow \infty} \left(\frac{n+3}{n+5} \right)^{3n+1};$$

$$27. \lim_{n \rightarrow \infty} \left(\frac{5n-1}{5n+2} \right)^{4n};$$

$$29. \lim_{n \rightarrow \infty} \left(\frac{9n+4}{9n+5} \right)^{2n};$$

$$20. \lim_{n \rightarrow \infty} \left(\frac{2n^2+2}{2n^2+1} \right)^{n^2};$$

$$22. \lim_{n \rightarrow \infty} \left(\frac{n^2+5}{n^2+4} \right)^{n^2};$$

$$24. \lim_{n \rightarrow \infty} \left(\frac{7n+1}{7n+4} \right)^{2n};$$

$$26. \lim_{n \rightarrow \infty} \left(\frac{3n^2+1}{3n^2+2} \right)^{n^2};$$

$$28. \lim_{n \rightarrow \infty} \left(\frac{8n+1}{8n-3} \right)^n;$$

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

Задача 6. Вычислить пределы числовых последовательностей

$$1. \lim_{x \rightarrow \infty} \frac{8x^5 - 4x^3 + 3}{2x^3 + x^2 - 7};$$

$$3. \lim_{x \rightarrow \infty} \frac{3x^4 + 2x - 5}{2x^2 + x + 7};$$

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

$$7. \lim_{x \rightarrow \infty} \frac{3x^4 + 2x^2 - 8}{8x^3 - 4x + 5};$$

$$9. \lim_{x \rightarrow \infty} \frac{4x^2 + 7x + 4}{x^4 + 5x - 1};$$

$$11. \lim_{x \rightarrow \infty} \frac{11x^2 + 3x}{2x^4 - 2x^2 + 1};$$

$$2. \lim_{x \rightarrow \infty} \frac{2x^2 + 3x + 7}{3x^4 - 2x^2 + x};$$

$$4. \lim_{x \rightarrow \infty} \frac{5x^4 - 4x^3 + 3}{2x^2 + 3x - 7};$$

$$6. \lim_{x \rightarrow \infty} \frac{3x - x^6}{x^2 - 2x + 5};$$

$$8. \lim_{x \rightarrow \infty} \frac{2x^4 + 3x^2 + 5}{3x^2 - 4x + 1};$$

$$10. \lim_{x \rightarrow \infty} \frac{7x^4 - 2x^2 + 4}{12x^2 + x - 5};$$

$$12. \lim_{x \rightarrow \infty} \frac{x^7 + 5x^2 - 4x}{3x^2 + 11x - 7};$$

$$13. \lim_{x \rightarrow \infty} \frac{2x^2 + 10x - 11}{3x^4 - 2x^2 + 5};$$

$$15. \lim_{x \rightarrow \infty} \frac{6x^4 + 5x^2 - 3}{2x^2 - x + 7};$$

$$17. \lim_{x \rightarrow \infty} \frac{x^5 - 2x + 4}{2x^4 + 3x^2 + 1};$$

$$19. \lim_{x \rightarrow \infty} \frac{5x^2 - 3x + 1}{1 + 2x - x^4};$$

$$21. \lim_{x \rightarrow \infty} \frac{8x^3 + x^2 - 7}{2x^2 - 5x + 3};$$

$$23. \lim_{x \rightarrow \infty} \frac{2x^3 + 7x - 1}{3x^4 + 2x + 5};$$

$$25. \lim_{x \rightarrow \infty} \frac{8x^2 + 3x + 5}{4x^3 - 2x^2 + 1};$$

$$27. \lim_{x \rightarrow \infty} \frac{4x^3 + 5x^2 - 3x}{3x^2 + x - 10};$$

$$29. \lim_{x \rightarrow \infty} \frac{7x^2 + 5x + 9}{1 + 4x - x^3};$$

$$14. \lim_{x \rightarrow \infty} \frac{3x^3 + 4x^2 - 7x}{2x^2 + 7x - 3};$$

$$16. \lim_{x \rightarrow \infty} \frac{3x^4 + x^2 - 6}{2x^2 + 3x + 1};$$

$$18. \lim_{x \rightarrow \infty} \frac{2x^2 - 7x + 1}{x^3 + 4x^2 - 3};$$

$$20. \lim_{x \rightarrow \infty} \frac{3x^2 + 7x - 4}{x^4 + 2x^2 - 1};$$

$$22. \lim_{x \rightarrow \infty} \frac{6x^2 - 5x + 2}{4x^3 + 2x - 1};$$

$$24. \lim_{x \rightarrow \infty} \frac{3x^4 + 2x^2 - 4}{3x^2 - 4x + 1};$$

$$26. \lim_{x \rightarrow \infty} \frac{3x^6 - 5x^2 + 2}{2x^4 + 4x^3 - 5};$$

$$28. \lim_{x \rightarrow \infty} \frac{3x^2 + 4x - 7}{x^4 - 2x^3 + 1};$$

$$30. \lim_{x \rightarrow \infty} \frac{7x^3 + 3x - 4}{2x^2 - 5x + 1}.$$

Задача 7. Найти предел функции

$$1. \lim_{x \rightarrow 4} \frac{3x^2 - 13x + 4}{x^2 - x - 12};$$

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

$$5. \lim_{x \rightarrow 2} \frac{x^3 - 8}{x^2 + x - 6};$$

$$7. \lim_{x \rightarrow 7} \frac{x^2 - 5x - 14}{2x^2 - 9x - 35};$$

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

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

$$6. \lim_{x \rightarrow 2} \frac{2x^2 - 9x + 10}{x^2 + 3x - 10};$$

$$8. \lim_{x \rightarrow 4} \frac{x^2 - 16}{x^2 + x - 20};$$

$$9. \lim_{x \rightarrow 2} \frac{-5x^2 + 11x - 2}{3x^2 - x - 10};$$

$$11. \lim_{x \rightarrow 3} \frac{3x^2 - 7x - 6}{2x^2 - 7x + 3};$$

$$13. \lim_{x \rightarrow -8} \frac{2x^2 + 15x - 8}{3x^2 + 25x + 8};$$

$$15. \lim_{x \rightarrow -5} \frac{x^2 - 2x - 35}{2x^2 + 11x + 5};$$

$$17. \lim_{x \rightarrow 3} \frac{3x^2 - 11x + 6}{2x^2 - 5x - 3};$$

$$19. \lim_{x \rightarrow 3} \frac{6 + x - x^2}{x^3 - 27};$$

$$21. \lim_{x \rightarrow 0} \frac{x^3 - x^2 + 2x}{x^2 + x};$$

$$23. \lim_{x \rightarrow -3} \frac{4x^2 + 11x - 3}{x^2 + 2x - 3};$$

$$25. \lim_{x \rightarrow \frac{1}{3}} \frac{3x^2 + 2x - 1}{27x^3 - 1};$$

$$27. \lim_{x \rightarrow 3} \frac{12 - x - x^2}{x^3 - 27};$$

$$29. \lim_{x \rightarrow -1} \frac{x^2 - 4x - 5}{4x^2 + 2x - 2};$$

$$10. \lim_{x \rightarrow -3} \frac{4x^2 + 7x - 15}{x^2 - 6x - 27};$$

$$12. \lim_{x \rightarrow 5} \frac{3x^2 - 6x - 45}{2x^2 - 3x - 35};$$

$$14. \lim_{x \rightarrow -1} \frac{5x^2 + 4x - 1}{3x^2 + x - 2};$$

$$16. \lim_{x \rightarrow 2} \frac{x^2 - 5x + 6}{x^2 - 12x + 20};$$

$$18. \lim_{x \rightarrow -3} \frac{2x^2 + 5x - 3}{3x^2 + 10x + 3};$$

$$20. \lim_{x \rightarrow -1} \frac{x^2 - x - 2}{x^3 + 1};$$

$$22. \lim_{x \rightarrow 2} \frac{2x^2 - 7x + 6}{x^2 - 5x + 6};$$

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

$$26. \lim_{x \rightarrow -2} \frac{4x^2 + 7x - 2}{3x^2 + 8x + 4};$$

$$28. \lim_{x \rightarrow 4} \frac{3x^2 - 2x - 40}{x^2 - 3x - 4};$$

$$30. \lim_{x \rightarrow -1} \frac{x^2 - 4x - 5}{x^2 - 2x - 3}.$$

Задача 8. Найти предел функции

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

$$3. \lim_{x \rightarrow 4} \frac{x^2 + 3x - 28}{x^3 - 64};$$

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

$$4. \lim_{x \rightarrow 2} \frac{x^3 - 8}{2x^2 - 9x + 10};$$

$$5. \lim_{x \rightarrow 2} \frac{3x^2 - 2x + 1}{x^3 - 8};$$

$$7. \lim_{x \rightarrow -2} \frac{x^2 + 2x}{x^2 + 4x + 4};$$

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

$$11. \lim_{x \rightarrow 1} \frac{4x^4 - 5x^2 + 1}{x^2 - 1};$$

$$13. \lim_{x \rightarrow -5} \frac{x^2 - x - 30}{x^3 + 125};$$

$$15. \lim_{x \rightarrow 2} \frac{x^3 - 2x^2 - 4}{x^2 - 11x + 18};$$

$$17. \lim_{x \rightarrow \frac{1}{2}} \frac{8x^3 - 1}{x^2 - \frac{1}{4}};$$

$$19. \lim_{x \rightarrow 1} \frac{x^3 - 3x + 2}{x^2 - 4x + 3};$$

$$21. \lim_{x \rightarrow 1} \frac{x^2 - 2x + 1}{2x^2 - 7x + 5};$$

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

$$25. \lim_{x \rightarrow 2} \frac{x^2 - x - 2}{5x^2 + 3x - 26};$$

$$27. \lim_{x \rightarrow 0} \frac{4x^3 - 2x^2 + 5x}{3x^2 + 7x};$$

$$29. \lim_{x \rightarrow 4} \frac{x^3 - 64}{7x^2 - 27x - 4};$$

$$6. \lim_{x \rightarrow 4} \frac{x^2 + 3x - 28}{x^2 - 4x};$$

$$8. \lim_{x \rightarrow 1} \frac{x^3 + x^2 - 2}{x^3 - x^2 - x + 1};$$

$$10. \lim_{x \rightarrow -2} \frac{x^2 - 4}{3x^2 + x - 10};$$

$$12. \lim_{x \rightarrow 6} \frac{2x^2 - 11x - 6}{3x^2 - 20x + 12};$$

$$14. \lim_{x \rightarrow -4} \frac{2x^2 + 7x - 4}{x^3 + 64};$$

$$16. \lim_{x \rightarrow -3} \frac{2x^2 + 11x + 15}{3x^2 + 5x - 12};$$

$$18. \lim_{x \rightarrow -5} \frac{4x^2 + 19x - 5}{2x^2 + 11x + 5};$$

$$20. \lim_{x \rightarrow -2} \frac{3x^2 + 11x + 10}{x^2 + 5x + 6};$$

$$22. \lim_{x \rightarrow 0} \frac{3x^2 + x}{4x^2 - 5x};$$

$$24. \lim_{x \rightarrow -2} \frac{9x^2 + 17x - 2}{x^2 + 2x};$$

$$26. \lim_{x \rightarrow -6} \frac{x^2 + 2x - 24}{2x^2 + 15x + 18};$$

$$28. \lim_{x \rightarrow -1} \frac{x^2 - 1}{x^2 + 3x + 2};$$

$$30. \lim_{x \rightarrow 3} \frac{3x^3 - 5x^2 - 1}{x^2 - 5x + 6}.$$

Задача 9. Найти предел функции

$$1. \lim_{x \rightarrow 0} \frac{3x}{\sqrt{5-x} - \sqrt{5+x}};$$

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

$$5. \lim_{x \rightarrow 9} \frac{\sqrt{2x+7} - 5}{3 - \sqrt{x}};$$

$$7. \lim_{x \rightarrow 0} \frac{\sqrt{1+3x^2} - 1}{x^3 + x^2};$$

$$9. \lim_{x \rightarrow 5} \frac{\sqrt{2x+1} - \sqrt{x+6}}{2x^2 - 7x - 15};$$

$$11. \lim_{x \rightarrow -4} \frac{\sqrt{x+20} - 4}{x^3 + 64};$$

$$13. \lim_{x \rightarrow 2} \frac{\sqrt{4x+1} - 3}{x^3 - 8};$$

$$15. \lim_{x \rightarrow 0} \frac{3x}{\sqrt{1+x} - \sqrt{1-x}};$$

$$17. \lim_{x \rightarrow 5} \frac{\sqrt{x+4} - 3}{\sqrt{x-1} - 2};$$

$$19. \lim_{x \rightarrow -2} \frac{\sqrt{2-x} - \sqrt{x+6}}{x^2 - x - 6};$$

$$21. \lim_{x \rightarrow 7} \frac{\sqrt{x-3} - 2}{\sqrt{x+2} - 3};$$

$$23. \lim_{x \rightarrow 0} \frac{2 - \sqrt{x^2 + 4}}{3x^2};$$

$$25. \lim_{x \rightarrow 0} \frac{\sqrt{7-x} - \sqrt{7+x}}{\sqrt{7x}};$$

$$2. \lim_{x \rightarrow 0} \frac{\sqrt{x^2 + 4} - 2}{\sqrt{x^2 + 16} - 4};$$

$$4. \lim_{x \rightarrow 4} \frac{2 - \sqrt{x}}{\sqrt{6x+1} - 5};$$

$$6. \lim_{x \rightarrow -1} \frac{3x^2 + 4x + 1}{\sqrt{x+3} - \sqrt{5+3x}};$$

$$8. \lim_{x \rightarrow 3} \frac{x^3 - 27}{\sqrt{3x} - x};$$

$$10. \lim_{x \rightarrow 1} \frac{3x^2 - 3}{\sqrt{8+x} - 3};$$

$$12. \lim_{x \rightarrow 0} \frac{\sqrt{x^2 + 2} - \sqrt{2}}{\sqrt{x^2 + 1} - 1};$$

$$14. \lim_{x \rightarrow 0} \frac{\sqrt{9+x} - 3}{x^2 + x};$$

$$16. \lim_{x \rightarrow -4} \frac{\sqrt{x+12} - \sqrt{4-x}}{x^2 + 2x - 8};$$

$$18. \lim_{x \rightarrow -1} \frac{\sqrt{5+x} - 2}{\sqrt{8-x} - 3};$$

$$20. \lim_{x \rightarrow 3} \frac{\sqrt{4x-3} - 3}{x^2 - 9};$$

$$22. \lim_{x \rightarrow 2} \frac{x^2 - 3x + 2}{\sqrt{5-x} - \sqrt{x+1}};$$

$$24. \lim_{x \rightarrow 3} \frac{\sqrt{5x+1} - 4}{x^2 + 2x - 15};$$

$$26. \lim_{x \rightarrow 3} \frac{x^2 + x - 12}{\sqrt{x-2} - \sqrt{4-x}};$$

$$27. \lim_{x \rightarrow 4} \frac{2x^2 - 9x + 4}{\sqrt{5-x} - \sqrt{x-3}};$$

$$29. \lim_{x \rightarrow -3} \frac{\sqrt{x+10} - \sqrt{4-x}}{2x^2 - x - 21};$$

$$28. \lim_{x \rightarrow 4} \frac{\sqrt{2x+1} - 3}{\sqrt{x-2} - \sqrt{2}};$$

$$30. \lim_{x \rightarrow -5} \frac{\sqrt{3x+17} - \sqrt{2x+12}}{x^2 + 8x + 15}.$$

Задача 10. Найти предел функции

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

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

$$5. \lim_{x \rightarrow 0} \frac{\sqrt[3]{8+3x-x^2} - 2}{\sqrt[3]{x^2 + x^3}};$$

$$7. \lim_{x \rightarrow -2} \frac{\sqrt[3]{x-6} + 2}{x+2};$$

$$9. \lim_{x \rightarrow 2} \frac{\sqrt[3]{4x} - 2}{\sqrt{2+x} - \sqrt{2x}};$$

$$11. \lim_{x \rightarrow -2} \frac{\sqrt[3]{x-6} + 2}{\sqrt[3]{x^3 + 8}};$$

$$13. \lim_{x \rightarrow 4} \frac{\sqrt[3]{16x} - 4}{\sqrt{4+x} - \sqrt{2x}};$$

$$15. \lim_{x \rightarrow 8} \frac{\sqrt{1-x} - 3}{2 + \sqrt[3]{x}};$$

$$17. \lim_{x \rightarrow 1} \frac{\sqrt{x-1}}{\sqrt[3]{x^2} - 1};$$

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

$$4. \lim_{x \rightarrow 1} \frac{\sqrt{x-1}}{\sqrt[3]{x^2} - 1};$$

$$6. \lim_{x \rightarrow 3} \frac{\sqrt{x+13} - 2\sqrt{x+1}}{\sqrt[3]{x^2 - 9}};$$

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

$$10. \lim_{x \rightarrow 8} \frac{\sqrt{9+2x} - 5}{\sqrt[3]{x^2} - 4};$$

$$12. \lim_{x \rightarrow 3} \frac{\sqrt[3]{9x} - 3}{\sqrt{3+x} - \sqrt{2x}};$$

$$14. \lim_{x \rightarrow 1} \frac{\sqrt[3]{x} - 1}{\sqrt{1+x} - \sqrt{2x}};$$

$$16. \lim_{x \rightarrow \frac{1}{3}} \frac{\sqrt[3]{\frac{x}{9}} - \frac{1}{3}}{\sqrt{\frac{1}{3} + x} - \sqrt{2x}};$$

$$18. \lim_{x \rightarrow \frac{1}{2}} \frac{\sqrt[3]{\frac{x}{4}} - \frac{1}{2}}{\sqrt{\frac{1}{2} + x} - \sqrt{2x}};$$

$$19. \lim_{x \rightarrow 16} \frac{\sqrt[4]{x} - 2}{\sqrt{x} - 4};$$

$$21. \lim_{x \rightarrow 8} \frac{\sqrt{x+1} - 3}{\sqrt[3]{x^2} - 4};$$

$$23. \lim_{x \rightarrow -8} \frac{10 - x - 6\sqrt{1-x}}{2 + \sqrt[3]{x}};$$

$$25. \lim_{x \rightarrow 3} \frac{\sqrt{x+13} - 2\sqrt{x+1}}{\sqrt[3]{x^2} - 9};$$

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

$$29. \lim_{x \rightarrow -2} \frac{\sqrt[3]{x-6} + 2}{x^3 + 8};$$

$$20. \lim_{x \rightarrow \frac{1}{4}} \frac{\sqrt[3]{\frac{x}{16}} - \frac{1}{4}}{\sqrt{\frac{1}{4} + x} - \sqrt{2x}};$$

$$22. \lim_{x \rightarrow 0} \frac{\sqrt[3]{27+x} - \sqrt[3]{27-x}}{\sqrt[3]{x^2} + \sqrt[5]{x}};$$

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

$$26. \lim_{x \rightarrow 0} \frac{\sqrt[3]{27+x} - \sqrt[3]{27-x}}{x + 2\sqrt[3]{x^4}};$$

$$28. \lim_{x \rightarrow 5} \frac{\sqrt{31+x} - 2\sqrt{x+4}}{\sqrt[3]{x^2} - 25};$$

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

Задача 11. Найти предел функции

$$1. \text{ а) } \lim_{x \rightarrow \infty} \left(\frac{3x-4}{3x+2} \right)^{2x};$$

$$2. \text{ а) } \lim_{x \rightarrow \infty} \left(\frac{2x-4}{2x} \right)^{3x};$$

$$3. \text{ а) } \lim_{x \rightarrow \infty} \left(\frac{x+3}{x-1} \right)^{x-4};$$

$$4. \text{ а) } \lim_{x \rightarrow \infty} \left(\frac{x+4}{x-1} \right)^{2x};$$

$$5. \text{ а) } \lim_{x \rightarrow \infty} \left(\frac{x-7}{x+1} \right)^{4x-2};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+3}{1+2x} \right)^{5x};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+3}{2x-1} \right)^{x-4};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{2x-1}{3x+4} \right)^x;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{2x+1}{3x+5} \right)^{x+5};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{3x-1}{x+1} \right)^x;$$

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

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{2x+1}{3x+5} \right)^{3x};$$

$$7. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{2x-4}{2x} \right)^{-3x};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{3x+5}{4x-1} \right)^{2x};$$

$$8. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x-7}{x} \right)^{2x+1};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{3x+1}{2x+5} \right)^{x+4};$$

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

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{4x+1}{3x+2} \right)^{3x};$$

$$10. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{2+3x}{5+3x} \right)^x;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{6x+2}{5x-1} \right)^{x+2};$$

$$11. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{2x+1}{2x-1} \right)^{x+2};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{3x+1}{2x+5} \right)^{x-1};$$

$$12. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x}{x+1} \right)^{2x-3};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{5x+3}{4x-1} \right)^{x^2};$$

$$13. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{4x-1}{4x+1} \right)^{2x};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{2x-1}{6x+1} \right)^{3x-8};$$

$$14. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x}{x-3} \right)^{2x+1};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{3x+4}{2x+1} \right)^x;$$

$$15. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x-1}{x} \right)^{3x};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{6x+5}{7x-1} \right)^{2x+1};$$

$$16. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{2x+5}{2x+1} \right)^{5x};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+1}{2x-3} \right)^{x+2};$$

$$17. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{2x-1}{2x+4} \right)^{3x-1};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+5}{7x+8} \right)^{3x};$$

$$18. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{3x+4}{3x+5} \right)^{x+1};$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{5x-1}{4x+3} \right)^{2x};$$

$$19. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x+2}{x+1} \right)^{2x+1} ;$$

$$20. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x+5}{x} \right)^{3x+4} ;$$

$$21. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{3x}{3x-2} \right)^{x-2} ;$$

$$22. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{2x}{2x-3} \right)^{3x} ;$$

$$23. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x+2}{x} \right)^{3-2x} ;$$

$$24. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{4+2x}{2x+1} \right)^{x+1} ;$$

$$25. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x-1}{x+4} \right)^{3x+2} ;$$

$$26. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x-1}{x-2} \right)^{3x} ;$$

$$27. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x+4}{x+8} \right)^{-3x} ;$$

$$28. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{x-2}{x+1} \right)^{2x-3} ;$$

$$29. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{3x+4}{3x} \right)^{-2x} ;$$

$$30. \text{ a) } \lim_{x \rightarrow \infty} \left(\frac{3+x}{5+x} \right)^{x+2} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{3x+2}{4x+1} \right)^{x^2} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{5x+1}{2x+3} \right)^{x-3} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+5}{3x+1} \right)^{x^2} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+1}{2x-3} \right)^{3x} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+2}{5x+1} \right)^{x^2} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{4+2x}{5x+3} \right)^{x+1} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x-1}{5x+4} \right)^{3x} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{6x-1}{x-2} \right)^{3x} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{7x+4}{x+8} \right)^{3x} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+5}{7x+8} \right)^{x-2} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+4}{3x+1} \right)^{4x+1} ;$$

$$\text{б) } \lim_{x \rightarrow +\infty} \left(\frac{x+3}{2x+5} \right)^{x^2} .$$

Задача 12. Найти предел функции

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

3. $\lim_{x \rightarrow 0} \frac{\cos 3x - \cos x}{2x^2};$

5. $\lim_{x \rightarrow 0} \frac{1 - \cos 4x}{x \sin x};$

7. $\lim_{x \rightarrow 0} \frac{\cos 2x - \cos 8x}{5x^2};$

9. $\lim_{x \rightarrow 0} \frac{\cos 6x - \cos 2x}{4x^2};$

11. $\lim_{x \rightarrow 0} \frac{\cos 4x - \cos 2x}{3x^2};$

13. $\lim_{x \rightarrow 0} \frac{\cos x - \cos 5x}{5x^2};$

15. $\lim_{x \rightarrow 0} \frac{\sin 4x + \sin 6x}{x \sin x};$

17. $\lim_{x \rightarrow 0} \frac{7x}{\sin x + \sin 7x};$

19. $\lim_{x \rightarrow 0} \frac{5x}{\sin 2x + \sin 6x};$

21. $\lim_{x \rightarrow 0} \frac{\sin 4x + \sin 8x}{5x};$

23. $\lim_{x \rightarrow 0} \frac{1 - \cos^2 4x}{x \arctg x};$

25. $\lim_{x \rightarrow 0} \frac{5x}{\sin x + \sin 9x};$

27. $\lim_{x \rightarrow 3} \frac{\cos x - \cos^3 x}{5x^2};$

29. $\lim_{x \rightarrow 0} \left(\frac{1}{\sin 2x} - \frac{1}{\operatorname{tg} 2x} \right);$

2. $\lim_{x \rightarrow 0} \frac{\sin 7x + \sin 3x}{x \sin x};$

4. $\lim_{x \rightarrow 0} \frac{\cos^2 x - \cos^2 2x}{x^2};$

6. $\lim_{x \rightarrow 0} \frac{1 - \cos^2 2x}{x \arcsin x};$

8. $\lim_{x \rightarrow 0} \frac{\sin 5x + \sin x}{\arcsin x};$

10. $\lim_{x \rightarrow 0} \frac{\operatorname{tg} 3x - \sin 3x}{2x^2};$

12. $\lim_{x \rightarrow 0} \frac{\sin 3x - \sin x}{x^2};$

14. $\lim_{x \rightarrow 0} \frac{\operatorname{tg} x - \sin x}{3x^2};$

16. $\lim_{x \rightarrow 0} \frac{1 - \cos 5x}{2x^2};$

18. $\lim_{x \rightarrow 0} \frac{1 - \cos 8x}{5x^2};$

20. $\lim_{x \rightarrow 0} \frac{\cos 2x - \cos x}{1 - \cos x};$

22. $\lim_{x \rightarrow 0} \frac{1 - \cos 8x}{1 - \cos 4x};$

24. $\lim_{x \rightarrow 0} \frac{\sin 4x + \sin 2x}{\arcsin x};$

26. $\lim_{x \rightarrow 0} \frac{\sin^2 3x - \sin x}{x^2};$

28. $\lim_{x \rightarrow 0} \frac{\sin^2 3x - \sin x}{x^2};$

30. $\lim_{x \rightarrow 0} \left(\frac{1}{\operatorname{tg} x} - \frac{1}{\sin x} \right).$

Задача 13. Вычислить пределы функций

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

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

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

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

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

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

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

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

17. $\lim_{x \rightarrow 0} \frac{2 \sin \sqrt{x(x+1)}}{\ln(1 + 2x)};$

19. $\lim_{x \rightarrow 0} \frac{\sqrt{1+x} - 1}{\sin \sqrt{x(x+2)}};$

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

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

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

6. $\lim_{x \rightarrow 0} \frac{2x}{\operatorname{tg}\left(2\pi\left(x + \frac{1}{2}\right)\right)};$

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

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

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

14. $\lim_{x \rightarrow 0} \frac{1 - \sqrt{3x+1}}{\cos\left(\frac{x+1}{2}\right)\pi};$

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

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

20. $\lim_{x \rightarrow 0} \frac{\sin \sqrt{x(x+\pi)}}{e^{3x} - 1};$

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

$$23. \lim_{x \rightarrow 0} \frac{e^{4x} - 1}{\sin\left(\pi\left(\frac{x}{2} + 1\right)\right)};$$

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

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

$$29. \lim_{x \rightarrow 0} \frac{tg\left(\pi\left(1 + \frac{x}{2}\right)\right)}{\ln(x+1)};$$

$$24. \lim_{x \rightarrow 0} \frac{1 - \cos x}{\sqrt[3]{3x - 1}};$$

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

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

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

Задача 14. Найти предел функции

$$1. \lim_{x \rightarrow \frac{\pi}{2}} \frac{2^{\cos^2 x} - 1}{\ln \sin x}$$

$$3. \lim_{x \rightarrow \pi} \frac{1 + \cos 3x}{\sin^2 7x}$$

$$5. \lim_{x \rightarrow 1} \frac{\sqrt{x^2 - x + 1} - 1}{\ln x}$$

$$7. \lim_{x \rightarrow \pi} \frac{\sin^2 x - tg^2 x}{(x - \pi)^4}$$

$$9. \lim_{x \rightarrow 1} \frac{\sqrt{x^2 - x + 1} - 1}{tg x \pi}$$

$$11. \lim_{x \rightarrow 2\pi} \frac{\sin 7x - \sin 3x}{e^{x^2} - e^{4\pi^2}}$$

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

$$4. \lim_{x \rightarrow \frac{\pi}{4}} \frac{1 - \sin 2x}{\sqrt[3]{x - 4x}};$$

$$6. \lim_{x \rightarrow 1} \frac{1 + \cos \pi x}{tg^2 \pi x}$$

$$8. \lim_{x \rightarrow \frac{\pi}{2}} \frac{tg 3x}{tg x}$$

$$10. \lim_{x \rightarrow \pi} \frac{\cos 5x - \cos x}{\sin^2 x}$$

$$12. \lim_{x \rightarrow 2} \frac{\sin 7\pi x}{\sin 8\pi x}$$

$$13. \lim_{x \rightarrow 2} \frac{\ln(5-2x)}{\sqrt{10-3x}-2}$$

$$15. \lim_{x \rightarrow 1} \frac{\sqrt{x^2-3x+3}-1}{\sin \pi x}$$

$$17. \lim_{x \rightarrow -2} \frac{\arcsin \frac{x+2}{2}}{3^{\sqrt{2+x+x^2}}-9}$$

$$19. \lim_{x \rightarrow \pi} \frac{\cos 3x - \cos x}{tg^2 2x}$$

$$21. \lim_{x \rightarrow \pi} \frac{x^3 - \pi^3}{e^{\sin^2 x} - 1} \sin 5x$$

$$23. \lim_{x \rightarrow -2} \frac{tg \pi x}{x+2}$$

$$25. \lim_{x \rightarrow \frac{\pi}{3}} \frac{1-2 \cos x}{\pi-3x}$$

$$27. \lim_{x \rightarrow 1} \frac{1-x^2}{\sin \pi x}$$

$$29. \lim_{x \rightarrow 1} \frac{3-\sqrt{10-x}}{\sin 3\pi x}$$

$$14. \lim_{x \rightarrow \pi} \frac{x^2 - \pi^2}{\sin x}$$

$$16. \lim_{x \rightarrow 4} \frac{2^x - 16}{\sin \pi x}$$

$$18. \lim_{x \rightarrow \frac{\pi}{4}} \frac{\ln tg x}{\cos 2x}$$

$$20. \lim_{x \rightarrow 2} \frac{\ln(9-2x^2)}{\sin 2\pi x}$$

$$22. \lim_{x \rightarrow \pi} \frac{\ln(2+\cos x)}{e^{\sin x} - 1}$$

$$24. \lim_{x \rightarrow \pi} \frac{1 - \sin \frac{x}{2}}{\pi - x}$$

$$26. \lim_{x \rightarrow 2} \frac{\arctg(x^2-2x)}{\sin 3\pi x}$$

$$28. \lim_{x \rightarrow 1} \frac{\cos\left(\frac{\pi x}{2}\right)}{1-\sqrt{x}}$$

$$30. \lim_{x \rightarrow \pi} \frac{\sin 5x}{tg 3x}$$

Задача 15. Найти предел функции

$$1. \lim_{x \rightarrow 0} (\cos \sqrt{x})^{\frac{1}{x}}$$

$$2. \lim_{x \rightarrow 0} \left(5 - \frac{4}{\cos x}\right)^{\frac{1}{\sin^2 3x}}$$

$$3. \lim_{x \rightarrow 0} \left(\cos x \right)^{\frac{1}{\sin \pi x}}$$

$$5. \lim_{x \rightarrow 0} \left(\operatorname{tg} \left(\frac{\pi}{4} - x \right) \right)^{\operatorname{ctg} x}$$

$$7. \lim_{x \rightarrow 0} \left(2 \cos x \right)^{\frac{1}{\sin^2 x}}$$

$$9. \lim_{x \rightarrow 0} \left(3 - \frac{2}{\cos x} \right)^{\frac{1}{\sin^2 x}}$$

$$11. \lim_{x \rightarrow 0} \left(\cos x \right)^{\frac{1}{\ln(1 + \sin^2 x)}}$$

$$13. \lim_{x \rightarrow 0} \left(-\sin^2 x \right)^{\frac{1}{\ln(1 + \operatorname{tg}^2 3x)}}$$

$$15. \lim_{x \rightarrow 0} \left(-\ln \cos x \right)^{\frac{1}{\operatorname{tg}^2 x}}$$

$$17. \lim_{x \rightarrow 1} \left(2x \right)^{\frac{\operatorname{tg} \pi x}{2}}$$

$$19. \lim_{x \rightarrow \frac{\pi}{4}} \left(\operatorname{tg} x \right)^{\frac{1}{\cos \left(-\frac{3\pi}{4} - x \right)}}$$

$$4. \lim_{x \rightarrow 0} \left(+\sin^2 3x \right)^{\frac{1}{\ln \cos x}}$$

$$6. \lim_{x \rightarrow 0} \left(-\cos 3x \right)^{\frac{1}{\ln(1 + x^2)}}$$

$$8. \lim_{x \rightarrow 0} \left(6 - \frac{5}{\cos x} \right)^{\operatorname{ctg}^2 x}$$

$$10. \lim_{x \rightarrow 1} \left(\frac{2 - x}{x} \right)^{\frac{1}{\ln(2 - x)}}$$

$$12. \lim_{x \rightarrow 0} \left(+\operatorname{tg}^2 x \right)^{\frac{1}{\ln(1 + 3x^2)}}$$

$$14. \lim_{x \rightarrow 0} \left(-\cos x \right)^{\frac{1}{2}}$$

$$16. \lim_{x \rightarrow \frac{\pi}{2}} \left(\operatorname{tg} \frac{x}{2} \right)^{\frac{1}{x - \frac{\pi}{2}}}$$

$$18. \lim_{x \rightarrow 3} \left(\frac{6 - x}{3} \right)^{\operatorname{tg} \frac{\pi x}{6}}$$

$$20. \lim_{x \rightarrow 2\pi} \left(\cos x \right)^{\frac{1}{\sin^2 2x}}$$

$$21. \lim_{x \rightarrow \pi} \left(\operatorname{ctg} \frac{x}{4} \right)^{\frac{1}{\cos\left(\frac{x}{2}\right)}}$$

$$22. \lim_{x \rightarrow \frac{\pi}{2}} \left(\operatorname{ctg} \frac{x}{2} \right)^{\frac{1}{\cos x}}$$

$$23. \lim_{x \rightarrow \frac{\pi}{4}} \left(\operatorname{tg} x \right)^{\operatorname{tg} 4x}$$

$$24. \lim_{x \rightarrow \frac{\pi}{2}} \left(\sin x \right)^{\frac{18 \sin x}{\operatorname{ctg} x}}$$

$$25. \lim_{x \rightarrow \frac{\pi}{2}} \left(1 + \cos x \right)^{\frac{1}{\sin 2x}}$$

$$26. \lim_{x \rightarrow 2\pi} \left(\cos x \right)^{\frac{1}{\sin^2 x}}$$

$$27. \lim_{x \rightarrow 4\pi} \left(\cos x \right)^{\frac{5}{\operatorname{tg} 5x \sin x}}$$

$$28. \lim_{x \rightarrow \frac{\pi}{2}} \left(\sin x \right)^{\operatorname{tg} x \cdot \operatorname{tg} 3x}$$

$$29. \lim_{x \rightarrow 2\pi} \left(\cos x \right)^{\frac{\operatorname{ctg} 2x}{\sin 3x}}$$

$$30. \lim_{x \rightarrow 4\pi} \left(\cos x \right)^{\frac{\operatorname{ctg} x}{\sin 4x}}$$

Задача 16. Доказать, что функции $f(x)$ и $\varphi(x)$ при $x \rightarrow 0$ являются бесконечно малыми одного порядка

$$1. f(x) = \sin x + \sin 5x$$

$$\varphi(x) = 2x;$$

$$2. f(x) = \frac{2x}{3-x}$$

$$\varphi(x) = 2x - x^2;$$

$$3. f(x) = \frac{3x^2}{1-x}$$

$$\varphi(x) = \frac{x^2}{4+x};$$

$$4. f(x) = \frac{x^2}{7+x}$$

$$\varphi(x) = 3x^3 - x^2;$$

$$5. f(x) = \frac{3x^2}{2+x}$$

$$\varphi(x) = 7x^2;$$

$$6. f(x) = \sin(x^2 + 5x)$$

$$\varphi(x) = x^3 - 25x;$$

7. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = 2x^3$

8. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \cos x - \cos^3 x$

9. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \frac{x^2}{5+x}$

10. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \arcsin 2x$

11. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \sin 8x$

12. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = 1 - \cos 4x$

13. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \sin 3x + \sin x$

14. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \sqrt{9-x} - 3$

15. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \cos 7x - \cos x$

16. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \cos 3x - \cos 5x$

17. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \operatorname{tg} 2x$

18. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = 1 - \cos^2 x$

19. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = 1 - \cos x$

20. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = 3\sin^2 4x$

21. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \operatorname{arctg}^2 3x$

22. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \operatorname{tg}(x^2 + x)$

23. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \sin 3x - \sin x$

24. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \arcsin(x^2 - x)$

25. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \cos 3x - \cos x$

26. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \sin 7x + \sin x$

27. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = x \sin 3x$

28. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \sqrt{4+x} - 2$

29. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \sqrt{1+x} - 1$

30. $f \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \sin(x^2 - 2x)$

$$\varphi(x) = \frac{5x^3}{4-x};$$

$$\varphi(x) = 6x^2;$$

$$\varphi(x) = \frac{4x^2}{x-1};$$

$$\varphi(x) = 8x;$$

$$\varphi \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \arcsin 5x;$$

$$\varphi \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = x \sin 2x;$$

$$\varphi(x) = 10x;$$

$$\varphi(x) = 2x;$$

$$\varphi(x) = 2x^2;$$

$$\varphi(x) = x^2;$$

$$\varphi \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \arcsin x;$$

$$\varphi(x) = 8x^2;$$

$$\varphi(x) = 3x^2;$$

$$\varphi(x) = x^2 - x^4;$$

$$\varphi(x) = 4x^2;$$

$$\varphi(x) = x^2 + 2x;$$

$$\varphi(x) = 5x;$$

$$\varphi(x) = x^3 - x;$$

$$\varphi(x) = 7x^2;$$

$$\varphi(x) = 4x;$$

$$\varphi \left(\begin{smallmatrix} \curvearrowright \\ \curvearrowright \end{smallmatrix} \right) = \operatorname{arctg}^2 x;$$

$$\varphi(x) = 34x;$$

$$\varphi(x) = 2x;$$

$$\varphi(x) = x^4 - 8x.$$

Задача 17. Найти предел функции

1. $\lim_{x \rightarrow 0} \frac{\arcsin 8x}{\operatorname{tg} 4x};$

3. $\lim_{x \rightarrow 0} \frac{\sin 3x}{\ln(1+2x)};$

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

7. $\lim_{x \rightarrow 0} \frac{e^{6x} - 1}{\operatorname{tg} 2x};$

9. $\lim_{x \rightarrow 0} \frac{\ln(1+5x)}{\sin 3x};$

11. $\lim_{x \rightarrow 0} \frac{1 - \cos 8x}{2x^2};$

13. $\lim_{x \rightarrow 0} \frac{1 - \cos 6x}{4x^2}.$

15. $\lim_{x \rightarrow 0} \frac{\sin 7x}{\operatorname{tg} 2x};$

17. $\lim_{x \rightarrow 0} \frac{\ln(x^2 + 1)}{x \sin x};$

19. $\lim_{x \rightarrow 0} \frac{\operatorname{arctg} 6x}{2x^2 - 3x};$

21. $\lim_{x \rightarrow 0} \frac{\sin 5x}{\operatorname{arctg} 2x};$

23. $\lim_{x \rightarrow 0} \frac{\ln(1+3x)}{\sin 12x};$

25. $\lim_{x \rightarrow 0} \frac{\operatorname{arctg} 5x}{\operatorname{tg} 2x};$

27. $\lim_{x \rightarrow 3} \frac{\operatorname{arctg} 3x}{\ln(1+2x)};$

2. $\lim_{x \rightarrow 0} \frac{e^{5x} - 1}{\sin 2x};$

4. $\lim_{x \rightarrow 0} \frac{\ln(1+4x)}{\sin 5x};$

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

8. $\lim_{x \rightarrow 0} \frac{\arcsin 4x}{\operatorname{tg} 8x};$

10. $\lim_{x \rightarrow 0} \frac{\ln(1+4x^3)}{2x^3};$

12. $\lim_{x \rightarrow 0} \frac{e^{3x} - 1}{\sin 6x};$

14. $\lim_{x \rightarrow 0} \frac{\arcsin 5x}{\operatorname{tg} 3x};$

16. $\lim_{x \rightarrow 0} \frac{\arcsin 4x}{\operatorname{tg} 5x};$

18. $\lim_{x \rightarrow 0} \frac{e^{9x} - 1}{x^3 + 27x};$

20. $\lim_{x \rightarrow 0} \frac{\arcsin 3x}{2x};$

22. $\lim_{x \rightarrow 0} \frac{\arcsin 2x}{\operatorname{tg} 4x};$

24. $\lim_{x \rightarrow 0} \frac{e^{2x} - 1}{\operatorname{tg} 6x};$

26. $\lim_{x \rightarrow 0} \frac{\ln(1+3x^2)}{x^3 - 5x^2};$

28. $\lim_{x \rightarrow 0} \frac{6x^2 - 5x}{\sin 2x};$

$$29. \lim_{x \rightarrow 0} \frac{\sin 7x}{x^2 + \pi x};$$

$$30. \lim_{x \rightarrow 0} \frac{x \sin 2x}{\ln(1 + 4x^2)}.$$

Задача 18. Исследовать функцию на непрерывность в указанных точках

$$1. \quad f(x) = \frac{x-4}{x+3} \quad x_1 = -3 \quad x_2 = -2;$$

$$2. \quad f(x) = \frac{2x}{x^2 - 1} \quad x_1 = 1 \quad x_2 = 2;$$

$$3. \quad f(x) = \frac{x+5}{x-3} \quad x_1 = 3 \quad x_2 = 4;$$

$$4. \quad f(x) = 2^{\frac{3}{x+2}} + 1 \quad x_1 = -2 \quad x_2 = -1;$$

$$5. \quad f(x) = \frac{4x}{x+5} \quad x_1 = -5 \quad x_2 = -4;$$

$$6. \quad f(x) = 3^{\frac{4}{1-x}} + 1 \quad x_1 = 1 \quad x_2 = 2;$$

$$7. \quad f(x) = 4^{\frac{3}{x-2}} \quad x_1 = 2 \quad x_2 = 3;$$

$$8. \quad f(x) = 3^{\frac{2}{x+1}} - 2 \quad x_1 = -1 \quad x_2 = 0;$$

$$9. \quad f(x) = 6^{\frac{2}{4-x}} \quad x_1 = 3 \quad x_2 = 4;$$

$$10. \quad f(x) = 5^{\frac{3}{x+4}} + 1 \quad x_1 = -5 \quad x_2 = -4;$$

$$11. \quad f(x) = \frac{x+1}{x-2} \quad x_1 = 2 \quad x_2 = 3;$$

$$12. \quad f(x) = \frac{x-4}{x+2} \quad x_1 = -2 \quad x_2 = -1;$$

$$13. \quad f(x) = 7^{\frac{1}{5-x}} + 1 \quad x_1 = 4 \quad x_2 = 5;$$

$$14. \quad f(x) = 2^{\frac{1}{x-3}} + 1 \quad x_1 = 3 \quad x_2 = 4;$$

$$15. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = \frac{x-3}{x+4} \quad x_1 = -5 \quad x_2 = -4;$$

$$16. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 5^{\frac{1}{x-3}} - 1 \quad x_1 = 3 \quad x_2 = 4;$$

$$17. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = \frac{x+5}{x-2} \quad x_1 = 3 \quad x_2 = 2;$$

$$18. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = \frac{x+7}{x-2} \quad x_1 = 2 \quad x_2 = 3;$$

$$19. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 5^{\frac{1}{x-3}} \quad x_1 = 3 \quad x_2 = 4;$$

$$20. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = \frac{x-5}{x+3} \quad x_1 = -2 \quad x_2 = -3;$$

$$21. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 4^{\frac{2}{1-x}} \quad x_1 = 1 \quad x_2 = 2;$$

$$22. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 4^{\frac{1}{3-x}} + 2 \quad x_1 = 2 \quad x_2 = 3;$$

$$23. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 2^{\frac{5}{1-x}} - 1 \quad x_1 = 0 \quad x_2 = 1;$$

$$24. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 9^{\frac{1}{2-x}} - 1 \quad x_1 = 0 \quad x_2 = 2;$$

$$25. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 8^{\frac{4}{x-2}} - 1 \quad x_1 = 2 \quad x_2 = 3;$$

$$26. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 2^{\frac{1}{x-5}} + 1 \quad x_1 = 4 \quad x_2 = 5;$$

$$27. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 5^{\frac{4}{3-x}} + 1 \quad x_1 = 2 \quad x_2 = 3;$$

$$28. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 5^{\frac{1}{x-4}} - 2 \quad x_1 = 3 \quad x_2 = 4;$$

$$29. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = \frac{3x}{x-4} \quad x_1 = 4 \quad x_2 = 5;$$

$$30. f \left(\left[\begin{smallmatrix} \bullet \\ \curvearrowright \end{smallmatrix} \right] \right) = 6^{\frac{1}{x-3}} + 3 \quad x_1 = 3 \quad x_2 = 4.$$

Задача 19. Исследовать функцию на непрерывность и построить график

$$1. f(x) = \begin{cases} -x+2 & x \leq -2 \\ x^3 & -2 < x \leq 1; \\ 2 & x > 1 \end{cases}$$

$$2. f(x) = \begin{cases} x^3 & x \leq -1 \\ x-1 & -1 < x \leq 3; \\ 5-x & x > 3 \end{cases}$$

$$3. f(x) = \begin{cases} 3x+4 & x \leq -1 \\ x^2-2 & -1 < x < 2; \\ 2 & x \geq 2 \end{cases}$$

$$4. f(x) = \begin{cases} x & x < -2 \\ 1-x & -2 \leq x \leq 1; \\ x^2-1 & x > 1 \end{cases}$$

$$5. f(x) = \begin{cases} x & x \leq 1 \\ (x-2)^2 & 1 < x \leq 3; \\ 6-x & x \geq 3 \end{cases}$$

$$6. f(x) = \begin{cases} x+3 & x \leq 0 \\ -x^2+4 & 0 < x < 2; \\ x-2 & x \geq 2 \end{cases}$$

$$7. f(x) = \begin{cases} x-1 & x \leq 1 \\ x^2+2 & 1 \leq x \leq 2; \\ -2x & x > 2 \end{cases}$$

$$8. f(x) = \begin{cases} 0 & x \leq -1 \\ x^2-1 & -1 < x \leq 2; \\ 2x & x > 2 \end{cases}$$

$$9. f(x) = \begin{cases} x+4 & x < -1 \\ x^2+2 & -1 \leq x < 1; \\ 2x & x \geq 1 \end{cases}$$

$$10. f(x) = \begin{cases} -1 & x < 0 \\ \cos x & 0 \leq x \leq \pi; \\ 1-x & x > \pi \end{cases}$$

$$11. f(x) = \begin{cases} x+1 & x \leq 0 \\ (x+1)^2 & 0 < x \leq 2; \\ 4-x & x > 2 \end{cases}$$

$$12. f(x) = \begin{cases} 2 & x \leq -1 \\ 1-x & -1 < x \leq 1; \\ \ln x & x > 1 \end{cases}$$

$$13. f(x) = \begin{cases} x+2 & x < -1 \\ x^2+1 & -1 \leq x < 1; \\ 3-x & x > 1 \end{cases}$$

$$14. f(x) = \begin{cases} -x & x \leq 0 \\ x^3 & 0 < x \leq 2; \\ x+4 & x > 2 \end{cases}$$

15. $f(x) = \begin{cases} -x & x \leq 0 \\ -(x-1)^2 & 0 < x < 2; \\ x-3 & x \geq 2 \end{cases}$ 16. $f(x) = \begin{cases} x-1 & x < 0 \\ x^2 & 0 < x < 2; \\ 2x & x \geq 2 \end{cases}$
17. $f(x) = \begin{cases} -2(x+1) & x \leq -1 \\ (x+1)^3 & -1 < x < 0; \\ x & x \geq 0 \end{cases}$ 18. $f(x) = \begin{cases} x+1 & x < 0 \\ x^2-1 & 0 < x < 2; \\ -x & x \geq 1 \end{cases}$
19. $f(x) = \begin{cases} -x & x \leq 0 \\ x^2 & 0 < x \leq 2; \\ x+1 & x > 2 \end{cases}$ 20. $f(x) = \begin{cases} -x & x < 0 \\ x^2+1 & 0 \leq x < 2; \\ x+1 & x \geq 2 \end{cases}$
21. $f(x) = \begin{cases} x^2+1 & x \leq 1 \\ 2x & 1 \leq x \leq 3; \\ x+2 & x > 3 \end{cases}$ 22. $f(x) = \begin{cases} x+3 & x < 0 \\ 1 & 0 < x \leq 2; \\ x^2-2 & x > 2 \end{cases}$
23. $f(x) = \begin{cases} x-3 & x < 0 \\ x+1 & 0 \leq x \leq 4; \\ x+3 & x > 4 \end{cases}$ 24. $f(x) = \begin{cases} x-1 & x < 0 \\ \sin x & 0 \leq x \leq \pi; \\ 3 & x \geq \pi \end{cases}$
25. $f(x) = \begin{cases} \sqrt{1-x} & x \leq 0 \\ 0 & 0 \leq x \leq 2; \\ x-2 & x > 2 \end{cases}$ 26. $f(x) = \begin{cases} 1-x & x \leq -1 \\ x^2+1 & -1 \leq x \leq 2; \\ 2x & x > 2 \end{cases}$
27. $f(x) = \begin{cases} 2x^2 & x \leq 0 \\ x & 0 < x \leq 1; \\ x+2 & x > 1 \end{cases}$ 28. $f(x) = \begin{cases} 1 & x \leq 0 \\ 2^x & 0 \leq x \leq 2; \\ x+3 & x > 2 \end{cases}$
29. $f(x) = \begin{cases} \sin x & x < 0 \\ x & 0 \leq x \leq 2; \\ 0 & x > 2 \end{cases}$ 30. $f(x) = \begin{cases} \cos x & x \leq \frac{\pi}{2} \\ 0 & \frac{\pi}{2} \leq x \leq \pi \\ 2 & x \geq \pi \end{cases}$

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