Task 1. In the items "1", "2" "3", "4", find the derivatives of the given functions;
in the item "5", find the derivative of the implicit function;
in the item "6", calculate approximately the value of function at a given *x* by means of the differential;
in the item "7", solve a problem using the geometrical meaning of the derivative.

1.1.
1) $y = e^{2x} arctg 2x + \frac{ln\, x}{x}$; 2) $y = ln^5\left(tg\sqrt[3]{x}\right)$; 3) $y = (ln\, x)^{sin 3x}$;

4) $\begin{cases} x = \frac{t+1}{t}, \\ y = \frac{t-1}{t}; \end{cases}$ 5) $\sqrt{xy} + sin\, x + sin\, a = 0$; 6) $y = x^3 + 3x^2 - 7, x = 2{,}03.$

7) Find the equation of line tangent to the curve $y = x \cdot ln\, x$, which is parallel to the straight line $y - x - 5 = 0$.

1.2.
1) $y = (x^2 - 2x + 3)e^{3x} - \frac{x}{ln\, x}$; 2) $y = 5^{arcsin^2(x^3 - x + 1)}$; 3) $y = (cos\, 3x)^x$;

4) $\begin{cases} x = a(t - sin t), \\ y = a(1 - cos\, t); \end{cases}$ 5) $y^3 sin\, x + a^2 cos\, 2x = 5a$; 6) $y = e^{x^2 - x}, x = 1{,}12.$

7) Find the equation of line normal to the curve $y = \frac{x-1}{x}$, which is parallel to the straight line $2y + x + 3 = 0$.

1.3.
1) $y = xtg 3x - \frac{5^x}{\sqrt{7x}}$; 2) $y = arccos^2\left(ln \frac{x}{1+x^2}\right)$; 3) $y = (sin\, 3x)^{ln\, x}$;

4) $\begin{cases} x = ln\left(1 + t^2\right), \\ y = t - arctgt; \end{cases}$ 5) $y^2 - 2xy + sin(x + y) = cos\, a$; 6) $y = e^{2-x}, x = 1{,}97.$

7) Find the equation of line tangent to the curve $y = 2 - \sqrt{x}$, which is perpendicular to the straight line $y + 4x - 4 = 0$.

1.4.
1) $y = \frac{e^{2x}(cos\, 3x + sin\, 3x)}{ln\, x}$; 2) $y = sin^3(cos\, 3x)$; 3) $y = \left(sin \frac{3}{x}\right)^{x^3}$;

4) $\begin{cases} x = t\, ln t, \\ y = \frac{t-1}{sin t}; \end{cases}$ 5) $x^4 + y^4 = x^2 y^2$; 6) $y = \left(x^2 - 3\right)^2 (x + 2), x = 3{,}011.$

7) Find the equations of lines tangent and normal to the curve $y=\frac{x^2+1}{x^3-1}$ at the point with abscissa $x_0=-1$.

1.5. 1) $y=x^{\frac{2}{3}} arccos\,2x-\frac{2x+3}{tg3x}$; 2) $y=ln^3 x+3^{tg3x}$;

3) $y=(sin\,x)^{\sqrt{x}}$; 4) $\begin{cases} x=a\,cos^3 t, \\ y=b\,sin^3 t; \end{cases}$ 5) $sin(x+y)+cos(x+y)=sin\,a;$

6) $y=arcsin3x, x=0{,}05.$

7) Find the equations of lines tangent and normal to the curve $y=\frac{x^2-3x+6}{x^2}$ at the point with abscissa $x_0=3$.

1.6. 1) $y=\sqrt{x}\,cos\,x+\frac{3x^2+7}{arcsin2x}$; 2) $y=e^{cos^3\left(ln\frac{1-x}{x^2}\right)}$; 3) $y=x^{sin\,x}$;

4) $\begin{cases} x=a\,cos\,t, \\ y=b\,sin\,t; \end{cases}$ 5) $x^y=y^x$; 6) $y=arctgx, x=0{,}98.$

7) Find the equation of line tangent to the curve $y=\frac{1}{1+x^2}$, which is parallel to the straight line $y=2x$.

1.7. 1) $y=3^{sin^2 ln\,x}$; 2) $y=\frac{x^2e^{2x}}{arctg2x}$; 3) $y=x^{cos\,2x}$;

4) $\begin{cases} x=4-t^2, \\ y=t-t^3; \end{cases}$ 5) $cos(xy)=sin(xy)$; 6) $y=2^{x-3}, x=2{,}08.$

7) 7) Find the equations of lines tangent and normal to the curve $y=\frac{1+3x^2}{3+x^2}$ at the point with abscissa $x_0=1$.

1.8. 1) $y=\frac{x\,cos\,4x}{1+tg4x}$; 2) $y=sin^5\left(4^{arctg\,2x}\right)$; 3) $y=(cos\,2x)^{tg\,2x}$;

4) $\begin{cases} x=t(1-sin\,t), \\ y=t\,cos\,t; \end{cases}$ 5) $ye^x-tgxy=e^a$; 6) $y=ln\,x, x=1{,}13.$

7) Find the equation of line tangent to the curve $y=x\cdot cos\,x$, which is perpendicular to the straight line $y+x+3=0$.

1.9.

$1)y=\frac{\sqrt[3]{x}2^{x}}{1+cos\,5x}$; $2)y=e^{\sqrt{cos^3 x}tg 3x}$; $3)y=(tg3x)^{x}$;

$4)\begin{cases} x=\frac{1+t^3}{t^2-1}, \\ y=\frac{t}{t^2-1}; \end{cases}$ $5)y-x=arctg\frac{x}{y}$; $6)y=\sqrt{1+x}, x=3{,}01$

7) Find the equation of line normal to the curve $y=e^{1-x^2}$, which is perpendicular to the straight line $y+2x-4=0$.

1.10.

$1)y=\left(\sqrt[3]{x+\sqrt{x+x}}\right)cos\,4x$; $2)y=ln^3\,tg\frac{x-1}{1-2x}$; $3)y=(sin\,5x)^{x^5}$;

$4)\begin{cases} x=e^{t}\,sin\,t, \\ y=e^{t}\,cos\,t; \end{cases}$ $5)y\,sin\,x-cos(x-y)=0$; $6)y=\sqrt[3]{\frac{1-x}{1+x}}, x=0{,}02.$

7) Find the equation of line normal to the curve $y=\sqrt[3]{1-x}$ at the point with abscissa $x_0=1$.

1.11.

$1)y=\left(\sqrt{x+x^3}\right)tg3x$; $2)y=cos\left(5^{ln\,x}\right)$; $3)y=\frac{x^3e^{3x}\,sin\,2x}{cos\,3x}$;

$4)\begin{cases} x=5\,cos^3\,t, \\ y=5\,sin^3\,t; \end{cases}$ $5)x\,sin\,y-cos\,y+cos\,2x=0$; $6)y=arccos\,x, x=0{,}01.$

7) Find the equation of line tangent to the curve $y=arcsin\frac{x-1}{2}$, which is parallel to the straight line $2y-x+5=0$.

1.12.

$1)y=\frac{arccos\,3x}{arcsin\,6x}$; $2)y=tg^3\,sin(ln\,2x)$; $3)y=\left(1+x^2\right)^{x^3}$; $4)\begin{cases} x=\frac{3t}{1+t}, \\ y=\frac{3t^2}{1+t^3}; \end{cases}$

$5)x+y=arcsin\,x+arcsin\,y$; $6)y=x^3-4x^2+6x+3, x=1{,}04.$

7) Find the equation of line tangent to the curve $y=arctgx$, which is perpendicular to the straight line $y+2x+3=0$.

1.13. $1)\ y=\dfrac{3x^3-5x^2+7}{arctg3x}$; $2)\ y=\sqrt[3]{ln^2\dfrac{sin\,x}{5-x^2}}$; $3)\ y=x^2\ sin\,2x(x+3)^5$;

$4)\begin{cases}x=3(t-sin\,t),\\ y=3(1-cos\,t);\end{cases}$ $5)\ 3^{x+y}=3^x-3^y$; $6)\ y=\sqrt[3]{1+x}, x=6{,}93.$

7) Find the equation of line normal to the curve $y=arccos\,3x$, which is perpendicular to the straight line $y+3x+3=0$.

1.14. $1)\ y=cos\,4x\cdot 2^x-5tg4x$; $2)\ y=3^{arccos^2(tg\,4x)}$; $3)\ y=(tg\,4x)^{ln\,x}$;

$4)\begin{cases}x=5^t(t^2+1),\\ y=5^t(1-t);\end{cases}$ $5)\ y\,ln(x+y)=ln\,a$; $6)\ y=e^{2-x-x^2}, x=-1{,}94.$

7) Find the equation of line tangent to the curve $y=\dfrac{x}{1+x^2}$ at the point with abscissa $x_0=2$.

1.15. $1)\ y=e^{3x}\ ln\,x-3\,arccos\,3x$; $2)\ y=\sqrt[3]{tg^2\ ln\sqrt{x}}$; $3)\ y=(sin\,2x)^{ctg\,2x}$;

$4)\begin{cases}x=\dfrac{1-t^2}{t},\\ y=\dfrac{t^3}{1+t};\end{cases}$ $5)\ x^{2/3}+y^{2/3}=a^{2/3}$; $6)\ y=\sqrt{9+x^2}, x=4{,}01.$

7) Find the equation of line normal to the curve $y=\sqrt{1+x^2}$ at the point with abscissa $x_0=0$.

1.15. $1)\ y=\dfrac{cos\,7x+3}{ln\,x+4}$; $2)\ y=sin^2\dfrac{x^5-x}{2-x}$; $3)\ y=(sin\,5x)^{cos\,5x}$;

$4)\begin{cases}x=3^t\ cos\,t,\\ y=3^t\ sin\,t;\end{cases}$ $5)\ tgy=atgx$; $6)\ y=\sqrt[3]{3x+cos\,x}, x=0{,}01.$

7) Find the equation of line tangent to the curve $y=x\cdot sin\,2x$, which is parallel to the straight line $y+\pi x+9=0$.

1.16. $1)\ y=4x^{-3/2}+x\sqrt[4]{x}-1$; $2)\ y=sin\sqrt[3]{1+x^3}$; $3)\ y=(x^3+5)^{ctg\,5x}$;

$4)\begin{cases}x=t^3\ ln\,t,\\ y=(1-t)\sqrt{t};\end{cases}$ $5)\ y=tg^2(y-x)$; $6)\ y=arctgx^2, x=0{,}97.$

7) Find the equations of lines tangent and normal to the curve $y=\frac{x^3+1}{x^2+4}$ at the point with abscissa $x_0=-1$.

1.18.
$1)\ y=\cos 2x\cdot 2^x-5tg3x;\ \ 2)\ y=\frac{\ln x}{\cos^3 3x};\ \ 3)\ y=(\cos 3x)^{\sin 5x};$

$4)\ \begin{cases} x=t^3\cos t, \\ y=(t^2-1)\sin t; \end{cases}\ \ 5)\ e^{xy}=\arcsin x;\ \ 6)\ y=\sqrt[3]{2+x^2},\ x=4{,}97.$

7) Find the equations of lines tangent and normal to the curve $y=e^{\sqrt{x}-1}$ at the point with abscissa $y_0=e$.

1.19.
$1)\ y=\frac{\sqrt[3]{x}\cdot tg3x}{1+\cos 4x};\ \ 2)\ y=\sqrt{\frac{2-\sin x}{2+\sin x}};\ \ 3)\ y=(ctg5x)^{x/3};$

$4)\ \begin{cases} x=\frac{t^3-3}{2t}, \\ y=\frac{t^2+1}{\ln t}; \end{cases}\ \ 5)\ x^3+ax^2y+y^3=a;\ \ 6)\ y=\frac{x^3-2}{x^2+1},\ x=1{,}07.$

7) Find the equation of line tangent to the curve $y=e^{\cos x}$, which is parallel to the straight line $y+x+3=0$.

1.20.
$1)\ y=\frac{x+\arcsin 2x}{3x+arctg3x};\ \ 2)\ y=\arcsin(\cos x^3);\ \ 3)\ y=(\arcsin 3x)^x;$

$4)\ \begin{cases} x=\cos^3 t, \\ y=\sin^3 t; \end{cases}\ \ 5)\ \cos(xy)=e^{x+y};\ \ 6)\ y=\sqrt[4]{2x-\sin\frac{\pi x}{2}},\ x=1{,}03.$

7) Find the equation of line tangent to the curve $y=x^3-3x^2-5$, which is perpendicular to the straight line $2x-6y+1=0$.

1.21.
$1)\ y=\sqrt[3]{x}\left(x^2-3\sqrt{x}+6\right);\ \ 2)\ y=\arccos(\sin x^2);\ \ 3)\ y=(arctg3x)^{x+3};$

$4)\ \begin{cases} x=t-\sin t, \\ y=1-\cos t; \end{cases}\ \ 5)\ 2y\ln y=e^x;\ \ 6)\ y=(x^2-1)^3(x+2),\ x=2{,}03.$

7) Find the equations of lines tangent and normal to the curve $y=x\cdot\ln(1+x^2)$ at the point with abscissa $x_0=1$.

$1)\, y = ((x+\sqrt{x}-1)tg5x)/x^3$; $2)\, y = \sqrt[4]{ln\, tg\, \frac{x}{3}}$; $3)\, y = (arctg5x)^{7+x}$;

1.22. $4)\begin{cases} x = t/(1-t^2), \\ y = t^2/(1-t^2); \end{cases}$ $5)\, 2^{x+y} = ln(x+y)$; $6)\, y = \frac{x^2+1}{1-x}, x = -0{,}93.$

7) Find the equations of lines tangent and normal to the curve $y = sin\, x + cos\, x$ at the point with abscissa $x_0 = \pi/4$.

$1)\, y = \frac{e^{2x} arctg3x}{cos\, 4x}$; $2)\, y = ln^3 x + ln(ctg3x)$; $3)\, y = (sin\, 3x)^{\frac{5}{x}}$;

1.23. $4)\begin{cases} x = \sqrt{1-t^3}, \\ y = t\sqrt{1+t}; \end{cases}$ $5)\, arctg\frac{x}{y} = ln\, y$; $6)\, y = arcsin\, 2x, x = 0{,}249.$

7) Find the equations of lines tangent and normal to the curve $y = 4^{x-x^2}$ at the point with abscissa $x_0 = 1$.

$1)\, y = \sqrt[4]{x^3} + 3^{-2x}$; $2)\, y = \sqrt[3]{ln\, sin\, \frac{x}{2}}$; $3)\, y = (arccos\, 5x)^{x+7}$;

1.24. $4)\begin{cases} x = \frac{t-2}{t}, \\ y = \frac{1-t}{\sqrt{t}}; \end{cases}$ $5)\, y^3 - 3y + 2a\, ln\, x = 0$; $6)\, y = \frac{1-x^2}{1+x^2}, x = 1{,}02.$

7) Find the equation of line tangent to the curve $y = 1 - \frac{1}{x^2}$, which is parallel to the straight line $2y + 32x + 7 = 0$.

$1)\, y = \frac{xe^{2x}}{sin\, 2x}$; $2)\, y = 4^{\frac{x}{cos\, 2x}}$; $3)\, y = \frac{(x-1)^2 \sqrt[3]{(x+1)^5}(x-3)^3}{(x^2+1)\sqrt[3]{(1-x)^5}}$;

1.25. $4)\begin{cases} x = t^5, \\ y = 1 - cos\, t; \end{cases}$ $5)\, arctg\sqrt{x/y} + sin\, y = ln\, a$; $6)\, y = \sqrt{5-x^2}, x = 0{,}98.$

7) Find the equations of lines tangent and normal to the curve $y = x - arctgx$ at the point with abscissa $x_0 = 1$.

$1)\, y = \frac{\sqrt[3]{x} \cdot 2^x}{sin\, 3x}$; $2)\, y = 5^{ctg^3(ln\sqrt{x})}$; $3)\, y = (ctg5x)^{\frac{7}{x}}$;

1.26. $4)\begin{cases} x = sin\, t + ln\, t, \\ y = cos\, t + ln\, t; \end{cases}$ $5)\, sin\sqrt{x+y} = ln\, tgy$; $6)\, y = e^{2x-x^2}, x = 2{,}014.$

7) Find the equation of line normal to the curve $y = x - \sqrt{x}$, which is pependicular to the straight line $4y - 3x + 5 = 0$.

1.27.

$$1)\ y = \frac{x \cdot arctg 4x}{ln\, x};\ \ 2)\ y = ln^2 x + ln(ln\, x);\ \ 3)\ y = (cos\, 2x)^{\frac{3}{x}};$$

$$4) \begin{cases} x = \sqrt{t}, \\ y = \sqrt[3]{t}; \end{cases}\ \ 5)\ arcsin\, xy = 2^x;\ \ 6)\ y = (3x-1)^2(x+1), x = 1{,}01.$$

7) Find the equations of lines tangent and normal to the curve $y = \frac{x^3 - 2}{x^2 - 4}$ at the point with abscissa $x_0 = 3$.

1.28.

$$1)\ y = \frac{e^{2x} \cdot sin\, 3x}{\sqrt[4]{x} + x^2};\ \ 2)\ y = 3^{tg^2\left(ln\sqrt{x}\right)};\ \ 3)\ y = (tg\, 4x)^{\frac{6}{x}};$$

$$4) \begin{cases} x = cos\, t + t\, sin\, t, \\ y = sin\, t - t\, cos\, t; \end{cases}\ \ 5)\ x\, ln(x+y) = a;\ \ 6)\ y = arctg\frac{x}{2}, x = 2{,}031.$$

7) Find the equations of lines tangent and normal to the curve $y = \sqrt[3]{x^2 - 1}$ at the point with abscissa $x_0 = 1$.

1.29.

$$1)\ y = \frac{\sqrt{x} \cdot cos\, 5x}{e^{2x}};\ \ 2)\ y = 5^{\frac{sin\, 3x}{x}};\ \ 3)\ y = \sqrt[3]{\frac{x^2(x^3+1) sin\, 2x}{x^2 - 2}};$$

$$4) \begin{cases} x = sin\, t, \\ y = 1 + t^3; \end{cases}\ \ 5)\ arccos\frac{x}{y} = 2^a;\ \ 6)\ y = x^4 - 2x^2 + 5, x = 2{,}03.$$

7) Find the equations of lines tangent and normal to the curve $y = xe^{-x^2}$ at the point with abscissa $x_0 = 1$.

1.30

$$1)\ y = \frac{1 - x^2}{1 + x^2} arcsin\, 2x;\ \ 2)\ y = cos^3(sin\, 2x);\ \ 3)\ y = \left(cos\frac{5}{x}\right)^{x^2};$$

$$4) \begin{cases} x = e^t(t^3 + 1); \\ y = e^t(1 - t^3); \end{cases}\ \ 5)\ ln\, tg\frac{y}{x} = a;\ \ 6)\ y = \sqrt{1 + x + sin\, x}; x = 0{,}02.$$

7) Find the equations of lines tangent and normal to the curve $y = x^3 + \sqrt[3]{x}$ at the point with abscissa $x_0 = -1$.

1.31. 1) $y = e^{2x} arctg 2x + \frac{ln\, x}{x}$; 2) $y = ln^5 \left(tg \sqrt[3]{x}\right)$; 3) $y = (ln\, x)^{sin 3x}$;

4) $\begin{cases} x = \frac{t+1}{t}, \\ y = \frac{t-1}{t}; \end{cases}$ 5) $\sqrt{xy} + sin\, x + sin\, a = 0$; 6) $y = x^3 + 3x^2 - 7, x = 2{,}03$.

7) Find the equation of line tangent to the curve $y = x \cdot ln\, x$, which is parallel to the straight line $y - x - 5 = 0$.

1.32. 1) $y = (x^2 - 2x + 3)e^{3x} - \frac{x}{ln\, x}$; 2) $y = 5^{arcsin^2(x^3 - x + 1)}$; 3) $y = (cos\, 3x)^x$;

4) $\begin{cases} x = a(t - sin t), \\ y = a(1 - cos\, t); \end{cases}$ 5) $y^3 sin\, x + a^2 cos\, 2x = 5a$; 6) $y = e^{x^2 - x}, x = 1{,}12$.

7) Find the equation of line normal to the curve $y = \frac{x-1}{x}$, which is parallel to the straight line $2y + x + 3 = 0$.

1.33. 1) $y = xctg 5x - \frac{3^x}{\sqrt{x^3}}$; 2) $y = \arcsin^4\left(\ln \frac{1+x^2}{x}\right)$; 3) $y = (\cos 3x)^{\ln x^2}$;

4) $\begin{cases} x = \ln(1 - t^2), \\ y = t^3 - arcctg 2t; \end{cases}$ 5) $y^2 + 5x^2 y + tg(x + y) = \cos a, a = const$; 6) $y = e^{1-x}, x = 0{,}97$.

7) Find the equation of line tangent to the curve $y = 2 - \sqrt{x}$, which is perpendicular to the straight line $y + 4x - 4 = 0$.

Task 2. Find the differential of the function: dy.

2.1. $y = x \arcsin(1/x) + \ln\left|x + \sqrt{x^2 - 1}\right|, \quad x > 0.$

2.2. $y = \operatorname{tg}\left(2 \arccos \sqrt{1 - 2x^2}\right), \quad x > 0.$

2.3. $y = \sqrt{1 + 2x} - \ln\left|x + \sqrt{1 + 2x}\right|$. 2.4. $y = x^2 \operatorname{arctg} \sqrt{x^2 - 1} - \sqrt{x^2 - 1}.$

2.5. $y = \arccos\left(1/\sqrt{1 + 2x^2}\right), \quad x > 0.$ 2.6. $y = x \ln\left|x + \sqrt{x^2 + 3}\right| - \sqrt{x^2 + 3}.$

2.7. $y = \operatorname{arctg}(\operatorname{sh} x) + (\operatorname{sh} x) \ln \operatorname{ch} x.$ 2.8. $y = \arccos\left((x^2 - 1)/(x^2 \sqrt{2})\right).$

2.9. $y=\ln\left(\cos^2 x+\sqrt{1+\cos^4 x}\right).$

2.10. $y=\ln\left(x+\sqrt{1+x^2}\right)-\sqrt{1+x^2}\,\mathrm{arctg}\,x.$

2.11. $y=\dfrac{\ln|x|}{1+x^2}-\dfrac{1}{2}\ln\dfrac{x^2}{1+x^2}$

2.12. $y=\ln\left(e^x+\sqrt{e^{2x}-1}\right)+\arcsin e^x.$

2.13. $y=x\sqrt{4-x^2}+a\arcsin(x/2).$

2.14. $y=\ln\mathrm{tg}(x/2)-x/\sin x.$

2.15. $y=2x+\ln|\sin x+2\cos x|.$

2.16. $y=\sqrt{\mathrm{ctg}\,x}-\sqrt{\mathrm{tg}^3 x}/3.$

2.17. $y=\ln\left|\dfrac{x+\sqrt{x^2+1}}{2x}\right|.$

2.18. $y=\sqrt[3]{\dfrac{x+2}{x-2}}.$

2.19. $y=\mathrm{arctg}\dfrac{x^2-1}{x}.$

2.20. $y=\ln\left|x^2-1\right|-\dfrac{1}{x^2-1}.$

2.21. $y=\mathrm{arctg}\left(\mathrm{tg}\dfrac{x}{2}+1\right).$

2.22. $y=\ln\left|2x+2\sqrt{x^2+x}+1\right|.$

2.23. $y=\ln\left|\cos\sqrt{x}\right|+\sqrt{x}\,\mathrm{tg}\sqrt{x}.$

2.24. $y=e^x(\cos 2x+2\sin 2x).$

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

2.26. $y=\left(\sqrt{x-1}-\dfrac{1}{2}\right)e^{2\sqrt{x-1}}.$

2.27. $y=\cos x\cdot\ln\mathrm{tg}\,x-\ln\mathrm{tg}\dfrac{x}{2}.$

2.28. $y=\sqrt{3+x^2}-x\ln\left|x+\sqrt{3+x^2}\right|.$

2.29. $y=\sqrt{x}-(1+x)\,\mathrm{arctg}\sqrt{x}.$

2.30. $y=x\,\mathrm{arctg}\,x-\ln\sqrt{1+x^2}.$

2.31. $y=x\sqrt{x^2-1}+\ln\left|x+\sqrt{x^2-1}\right|.$

2.32. $y=\mathrm{arctg}\,x+\dfrac{5}{6}\ln\dfrac{x^2+1}{x^2+4}.$

2.33. $y=\mathrm{arctg}\dfrac{\sqrt{1-x}}{1-\sqrt{x}}.$

Task 3. Find the derivative of the high order.

3.1. $y = (2x^2 - 7)\ln(x-1), y^{III} - ?$

3.2. $y = (3 - x^2)\ln^2 x, \quad y^{III} = ?$

3.3. $y = x\cos x^2, \quad y^{III} = ?$

3.4. $y = \frac{\ln(x-1)}{\sqrt{x-1}}, \quad y^{III} = ?$

3.5. $y = \frac{\log_2 x}{x^3}, \quad y^{III} = ?$

3.6. $y = (4x^3 + 5)e^{2x+1}, y^{III} - ?$

3.7. $y = x^2 \sin(5x - 3), \quad y^{III} = ?$

3.8. $y = \frac{\ln x}{x^2}, y^{III} - ?$

3.9. $y = (2x+3)\ln^2 x, \quad y^{III} = ?$

3.10. $y = (1 + x^2)\operatorname{arctg} x, \quad y^{III} = ?$

3.11. $y = \frac{2^x}{x^3}, y^{III} - ?$

3.12. $y = (4x + 3)2^{-x}, y^{III} - ?$

3.13. $y = e^{1-2x}\sin(2x+3), \mathrm{y}^{\mathrm{III}} - ?$

3.14. $y = \frac{\ln(3+x)}{3+x}, \quad y^{III} = ?$

3.15. $y = (2x^3 + 1)\cos x, y^{III} - ?$

3.16. $y = (x^2 + 3)\ln(x - 3), y^{III} - ?$

3.17. $y = (1 - x - x^2)e^{x+1}, y^{III} - ?$

3.18. $y = \frac{1}{x}\sin 2x, \quad y^{III} = ?$

3.19. $y = (x + 7)\ln(x + 4), y^{III} - ?$

3.20. $y = (3x - 7)3^{-x}, y^{III} - ?$

3.21. $y = \frac{\ln(2x+5)}{2x+5}, \quad y^{III} = ?$

3.22. $y = e^{\frac{x}{2}}\sin(2x), \mathrm{y}^{\mathrm{III}} - ?$

3.23. $y = \frac{\ln x}{x^5}, \quad y^{III} = ?$

3.24. $y = x \ln(1 - 3x), y^{III} - ?$

3.25. $y = (x^2 + 3x + 1)e^{3x+1}, y^{III} - ?$

3.26. $y = (5x - 8)2^{-x}, y^{III} - ?$

3.27. $y = \frac{\ln(x-2)}{x+2}, y^{III} - ?$

3.28. $y = e^{-x}(\sin 2x - \cos 3x), \mathrm{y}^{\mathrm{III}} - ?$

3.29. $y = (5x - 1)\ln^2 x, \quad y^{III} = ?$

3.30. $y = \frac{\log_3 x}{x^2}, y^{III} - ?$

3.31. $y = (x^3 + 1)e^{4x}, y^{III} - ?$

3.32 $y = \frac{\ln(2x)}{x^2}, y^{III} - ?$

3.33 $y = x\cos x^2, \quad y^{III} = ?$

Task 4. Find the second order derivative of the function given parametrical equations:

4.1. $\begin{cases} x = \cos 2t, \\ y = 2\sec^2 t. \end{cases}$

4.2. $\begin{cases} x = \sqrt{1-t^2}, \\ y = 1/t. \end{cases}$

4.3. $\begin{cases} x = \mathrm{e}^t \cos t, \\ y = \mathrm{e}^t \sin t. \end{cases}$

4.4. $\begin{cases} x = \mathrm{sh}^2 t, \\ y = 1/\mathrm{ch}^2 t. \end{cases}$

4.5. $\begin{cases} x = t + \sin t, \\ y = 2 - \cos t. \end{cases}$

4.6. $\begin{cases} x = 1/t, \\ y = 1/\left(1+t^2\right). \end{cases}$

4.7. $\begin{cases} x = \sqrt{t}, \\ y = 1/\sqrt{1-t}. \end{cases}$

4.8. $\begin{cases} x = \sin t, \\ y = \sec t. \end{cases}$

4.9. $\begin{cases} x = \mathrm{tg}\, t, \\ y = 1/\sin 2t. \end{cases}$

4.10. $\begin{cases} x = \sqrt{t-1}, \\ y = t/\sqrt{1-t}. \end{cases}$

4.11. $\begin{cases} x = \sqrt{t}, \\ y = \sqrt[3]{t-1}. \end{cases}$

4.12. $\begin{cases} x = \cos t/\left(1+2\cos t\right), \\ y = \sin t/\left(1+2\cos t\right). \end{cases}$

4.13. $\begin{cases} x = \sqrt{t^3-1}, \\ y = \ln t. \end{cases}$

4.14. $\begin{cases} x = \mathrm{sh}\, t, \\ y = \mathrm{th}^2 t. \end{cases}$

4.15. $\begin{cases} x = \sqrt{t-1}, \\ y = 1/\sqrt{t}. \end{cases}$

4.16. $\begin{cases} x = \cos^2 t, \\ y = \mathrm{tg}^2 t. \end{cases}$

4.17. $\begin{cases} x = \sqrt{t-3}, \\ y = \ln\left(t-2\right). \end{cases}$

4.18. $\begin{cases} x = \sin t, \\ y = \ln\cos t. \end{cases}$

4.19. $\begin{cases} x = t + \sin t, \\ y = 2 + \cos t. \end{cases}$

4.20. $\begin{cases} x = t - \sin t, \\ y = 2 - \cos t. \end{cases}$

4.21. $\begin{cases} x = \cos t, \\ y = \ln \sin t. \end{cases}$

4.22. $\begin{cases} x = \cos t + t\sin t, \\ y = \sin t - t\cos t. \end{cases}$

4.23. $\begin{cases} x = \mathrm{e}^t, \\ y = \arcsin t. \end{cases}$

4.24. $\begin{cases} x = \cos t, \\ y = \sin^4 (t/2). \end{cases}$

4.25. $\begin{cases} x = \mathrm{ch}\, t, \\ y = \sqrt[3]{\mathrm{sh}^2 t}. \end{cases}$

4.26. $\begin{cases} x = \mathrm{arctg}\, t, \\ y = t^2/2. \end{cases}$

4.27. $\begin{cases} x = 2(t - \sin t), \\ y = 4(2 + \cos t). \end{cases}$

4.28. $\begin{cases} x = \sin t - t\cos t, \\ y = \cos t + t\sin t. \end{cases}$

4.29. $\begin{cases} x = 1/t^2, \\ y = 1/(t^2 + 1). \end{cases}$

4.30. $\begin{cases} x = \cos t + \sin t, \\ y = \sin 2t. \end{cases}$

4.31. $\begin{cases} x = \ln t, \\ y = \mathrm{arctg}\, t. \end{cases}$

4.32. $\begin{cases} x = t + \sin t, \\ y = 2 - \cos t. \end{cases}$

4.33. $\begin{cases} x = \sqrt{t^3 - 1}, \\ y = \ln t. \end{cases}$

Task 5. Find the limits using H'Lopital rule:

5.1 a) $\lim\limits_{x\to 0} \dfrac{ln sin 3x}{ln sin 7x}$, b) $\lim\limits_{x\to 0} \left(ln \dfrac{1}{x} \right)^{sin x}$.

5.2. a) $\lim\limits_{x\to 1} \left(\dfrac{x}{x-1} - \dfrac{1}{ln x} \right)$, b) $\lim\limits_{x\to 0} x^{\frac{3}{4+ln x}}$.

5.3. a) $\lim\limits_{x\to 0} \dfrac{sin^3 x}{sin 2x - tg 2x}$, b) $\lim\limits_{x\to \frac{\pi}{2}-0} (tg x)^{2x-\pi}$.

5.4. a) $\lim\limits_{x\to 2}\dfrac{2^x - x^2}{x-2}$, b) $\lim\limits_{x\to\infty}\left(\dfrac{2}{\pi} arctgx\right)^x$.

5.5. a) $\lim\limits_{x\to 3}\dfrac{x^x - 3^3}{x-3}$, b) $\lim\limits_{x\to 0}(arcsin\,x + x)^x$.

5.6. a) $\lim\limits_{x\to 0}\dfrac{lnx}{1+2lnsinx}$, b) $\lim\limits_{x\to +0} ln(ctg\,x)^{tgx}$.

5.7. a) $\lim\limits_{x\to 0}\dfrac{x - sinx}{x^3}$, b) $\lim\limits_{x\to +0} x^{\frac{1}{\ln(e^x - 1)}}$.

5.8. a) $\lim\limits_{x\to 0}\dfrac{e^x\ sin\,x - x(1+x)}{x^3}$, b) $\lim\limits_{x\to +0}\left(ln\dfrac{1}{arcsin\,x}\right)^{tgx}$.

5.9. a) $\lim\limits_{x\to 0}\left(\dfrac{1}{x} - \dfrac{1}{sinx}\right)$, b) $\lim\limits_{x\to 0}(ctg\,x)^{1/ln\,x}$

5.10. a) $\lim\limits_{x\to 0}\dfrac{1}{x}\left(\dfrac{1}{x} - ctgx\right)$, b) $\lim\limits_{x\to\infty} x^{\frac{3}{1+ln\,x}}$.

5.11. a) $\lim\limits_{x\to 0}\left(\dfrac{1}{x} - \dfrac{1}{e^x - 1}\right)$, b) $\lim\limits_{x\to +\infty}\left(\ ln\,x\ \right)^{1/x}$.

5.12. a) $\lim\limits_{x\to 0}\dfrac{ln\,arcsin\,x - ln\,x}{tg^2\,2x}$, b) $\lim\limits_{x\to 0}(\,tg\,x\,)^x$.

5.13. a) $\lim\limits_{x\to 0}\dfrac{arcsin\,2x - 2\,arcsin\,x}{x^3}$, b) $\lim\limits_{x\to\infty}\left(tg\dfrac{\pi x}{2x+1}\right)^{1/x}$.

5.14. a) $\lim\limits_{x\to 0}\dfrac{ln(e^x - 1) - lnx}{x}$, b) $\lim\limits_{x\to 0}\left(\dfrac{2^x - x\ln 2}{3^x - x\ln 3}\right)^{1/x}$.

5.15. a) $\lim\limits_{x\to 0}\dfrac{ln(ln(1+x))-lnx}{x}$, b) $\lim\limits_{x\to 0}\left(\dfrac{arcsin\,x}{x}\right)^{ctg^2x}$.

5.16. a) $\lim\limits_{x\to 0}\dfrac{xctgx-1}{tg^2x}$, b) $\lim\limits_{x\to 0}\left(\dfrac{1}{x}\right)^{sin\,x}$.

5.17. a) $\lim\limits_{x\to 0}\left(\dfrac{1}{ln\left(x+\sqrt{x^2+1}\right)}-\dfrac{1}{ln(1+x)}\right)$, b) $\lim\limits_{x\to 0}x^x$.

5.18. a) $\lim\limits_{x\to 0}\dfrac{tgx-x}{x-sin\,x}$, b) $\lim\limits_{x\to 0}\left(\dfrac{sin\,x}{x}\right)^{1/x^2}$.

5.19. a) $\lim\limits_{x\to 0}x\,ln\,x$, b) $\lim\limits_{x\to 0}\left(\dfrac{(1+x)^{1/x}}{e}\right)^{1/x}$.

5.20. a) $\lim\limits_{x\to 0}x^3e^{-x}$, b) $\lim\limits_{x\to 0}(sinx)^{tg\,x}$.

5.21. a) $\lim\limits_{x\to 0}\dfrac{tg\,2x-ln(1+2x)}{x^2}$, b) $\lim\limits_{x\to +\infty}\left(\dfrac{\pi}{2}-arctgx\right)^{1/ln\,x}$.

5.22. a) $\lim\limits_{x\to 1}\arcsin\left(\dfrac{x-1}{1}\right)ctg(x-1)$, b) $\lim\limits_{x\to +\infty}\left(arcctgx\right)^{1/ln\,x}$.

5.23. a) $\lim\limits_{x\to 0}\left(\dfrac{1}{x^2}-ctg^2x\right)$, b) $\lim\limits_{x\to 0}\left(xctgx\right)^{1/ln\left(e^x+x\right)}$.

5.24. a) $\lim\limits_{x\to 1}\dfrac{x^x-1}{ln\,x-x+1}$, b) $\lim\limits_{x\to 0}(1-ln\,cos\,x)^{ctg^2x}$.

5.25. a) $\lim\limits_{x\to 0}\frac{(3+x)^3-3^3}{x^2}$, b) $\lim\limits_{x\to 1}\left(\frac{1-ln\,x}{x}\right)^{ctg\,(x-1)}$.

5.26. a) $\lim\limits_{x\to 0}\frac{sin\,x-x\,cos\,x}{x-sin\,x}$, b) $\lim\limits_{x\to 0}\left(\frac{2}{\pi}arccos\,x\right)^{\frac{1}{x}}$.

5.27. a) $\lim\limits_{x\to 0}\left(\frac{1}{x}-ctgx\right)$, b) $\lim\limits_{x\to 0}(ln\,cos\,x)^{tgx}$.

5.28. a) $\lim\limits_{x\to\infty}\left(x-x^2\,ln\left(1+\frac{1}{x}\right)\right)$, b) $\lim\limits_{x\to 0}\left(e^x+arctgx\right)^{1/x}$.

5.29. a) $\lim\limits_{x\to 0}\frac{x-arctgx}{x^3}$, b) $\lim\limits_{x\to 0}(5^x+x\ln 5)^{ctgx}$.

5.30. a) $\lim\limits_{x\to 0}\left(\frac{1}{x\,sin\,x}-\frac{1}{x^2}\right)$, b) $\lim\limits_{x\to 1}\left(\frac{x}{ln\,x}\right)^{tg\,(x-1)}$.

5.31. a) $\lim\limits_{x\to 0}\left(\frac{1}{x}-\frac{1}{e^x-1}\right)$, b) $\lim\limits_{x\to +\infty}\left(ln\,x\right)^{1/x}$.

5.32. a) $\lim\limits_{x\to 1}\left(\frac{x}{x-1}-\frac{1}{lnx}\right)$, b) $\lim\limits_{x\to 0}x^{\frac{3}{4+lnx}}$.

5.33. a) $\lim\limits_{x\to 0}\frac{arcsin\,2x-2\,arcsin\,x}{x^3}$, b) $\lim\limits_{x\to\infty}\left(tg\,\frac{\pi x}{2x+1}\right)^{1/x}$.

Task 6. Using the methods of differential calculus to investigate the following functions and plot their graphs

6.1. a) $y=\frac{x}{2(x-1)^2}$; b) $y=\frac{x}{e^x}$.

6.16 a) $y=\frac{x^4-81}{3x^2}$; b) $y=\frac{\sqrt{x}}{ln\,x}$.

6.2. a) $y=\dfrac{8x}{4+x^2}$;

b) $y=\dfrac{e^x}{x}$.

6.17. a) $y=\dfrac{16}{x^2(x-4)}$;

b) $y=2\,ln\dfrac{x}{x+1}-1$.

6.3. a) $y=\dfrac{3x-2}{x^2}$;

b) $y=\dfrac{e^{\frac{1}{2}(x+1)}}{x+1}$.

6.18. a) $y=\dfrac{x^2+1}{x^2-1}$;

b) $y=4e^{-x^2/2}$.

6.4. a) $y=\dfrac{x^2}{x-1}$;

b) $y=ln\left(1+x^2\right)$.

6.19. a) $y=\dfrac{3x^4+1}{x^3}$;

b) $y=(3-x)e^{x-2}$.

6.5. a) $y=\dfrac{x^3+125}{12x}$;

b) $y=ln(x+1)-x$.

6.20. a) $y=\dfrac{2x}{1-x^2}$;

b) $y=x\,ln\,x$.

6.6. a) $y=\dfrac{x^2}{x^2-1}$;

b) $y=2e^{-x^2}x$.

6.21. a) $y=x^2-\dfrac{2}{x}$;

b) $y=2xe^{-1/2x}$.

6.7. a) $y=\dfrac{4x-12}{(x-2)^2}$;

b) $y=\dfrac{ln\,x}{x}$.

6.22. a) $y=\dfrac{1-x^3}{x^2}$;

b) $y=x+\dfrac{ln\,x}{x}$.

6.8. a) $y=\dfrac{2x-1}{(x-1)^2}$;

b) $y=4xe^{-x}$.

6.23. a) $y=\dfrac{x^2-2x+2}{x-1}$;

b) $y=\dfrac{e^{2(x-1)}}{2(x-1)}$.

6.9. a) $y=\dfrac{x^4-3}{x}$;

b) $y=(2x+3)e^{-2(x+1)}$.

6.10. a) $y=\dfrac{2x}{x^2+1}$;

b) $y=\dfrac{4\ln x}{x}$.

6.11. a) $y=\dfrac{x^4+4}{x^2}$;

b) $y=3-3\ln\dfrac{x}{x+4}$.

6.12. a) $y=x-1+\dfrac{1}{x+1}$;

b) $y=2xe^{-1/2x}$.

6.13 a) $y=\dfrac{x}{\sqrt[3]{x^2-1}}$;

b) $y=\dfrac{e^{2(x+2)}}{2(x+2)}$.

6.14. a) $y=\dfrac{2x^3}{x^2+1}$;

b) $y=\ln(x^2-2x+2)$.

6.15. a) $y=\dfrac{x^2-1}{x^2+1}$;

b) $y=8xe^{-x/2}$.

6.24. a) $y=\dfrac{(x^2+1)^2}{x^2+2}$;

b) $y=\dfrac{x}{\ln x}$.

6.25. a) $y=\dfrac{4x}{(x+1)^2}$;

b) $y=\ln\dfrac{x}{x-2}-2$.

6.26. a) $y=\dfrac{x}{x^2-4}$;

b) $y=3x\ln x$.

6.27. a) $y=\dfrac{1-2x}{x^2}$;

b) $y=\dfrac{e^{3-x}}{3-x}$.

6.28. a) $y=\dfrac{x}{3-x^2}$;

b) $y=\dfrac{e^{2x}}{x}$.

6.29. a) $y=\dfrac{x^3-4}{2x^2}$;

b) $y=2\ln\dfrac{x+3}{x}-3$.

6.30. a) $y=\dfrac{x}{(1-x)^2}$;

b) $y=\dfrac{\ln x}{2x}$.

6.31. a) $y = \dfrac{x}{2(x-1)^2}$;

b) $y = \dfrac{x}{e^x}$.

6.32. a) $y = x - 1 + \dfrac{1}{x+1}$;

b) $y = 2xe^{-\frac{1}{2}x}$.

6.33 a) $y = \dfrac{x^4 - 81}{3x^2}$;

b) $y = \dfrac{\sqrt{x}}{\ln x}$.

6.34. a) $y = \dfrac{1-2x}{x^2}$;

b) $y = \dfrac{e^{3-x}}{3-x}$.