Soluzioni

18. pag. 16

$\left[\textit{Ad esempio}: (4,7); (3,6); \left(\frac{5}{2}, \frac{11}{2}\right); \textit{infiniti} \right]$

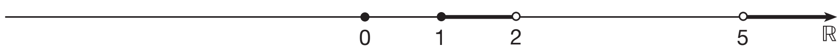
19. pag. 16

$[\textit{Ad esempio}: (-3,2) \text{ e } (1,6); \textit{sì, se } a \neq b]$

20. pag. 16

$\left[\textit{Sì, ad esempio}: \left(-\frac{7}{2}, \frac{5}{2}\right); \textit{no}; \textit{no} \right]$

21. pag. 17

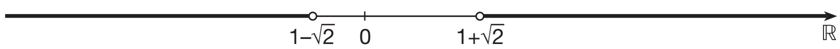
[*a*) 1) 

2) *punti interni* $1 < x < 2 \vee x > 5$

punti di accumulazione $1 \leq x \leq 2 \vee x \geq 5$

punti isolati $x = 0$ $FE = \{0, 1, 2, 5\}$

3) *E è un insieme né aperto né chiuso*

b) 1) 

2) *punti interni* $x < 1 - \sqrt{2} \vee x > 1 + \sqrt{2}$

punti di accumulazione $x \leq 1 - \sqrt{2} \vee x \geq 1 + \sqrt{2}$

punti isolati nessuno $FE = \left\{1 - \sqrt{2}, 1 + \sqrt{2}\right\}$

3) *E è un insieme aperto*

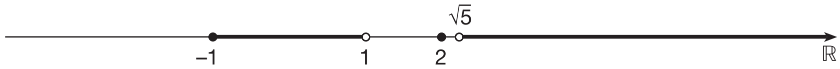
c) 1) 

2) *punti interni* $0 < x < 3 \vee x > 7$

punti di accumulazione $0 \leq x \leq 3 \vee x \geq 7$

punti isolati $x = -\frac{1}{5} \vee x = 4$ $FE = \left\{-\frac{1}{5}, 0, 3, 4, 7\right\}$

3) *E è un insieme né aperto né chiuso*

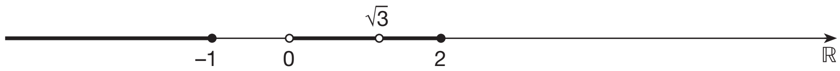
d) 1) 

2) *punti interni* $-1 < x < 1 \vee x > \sqrt{5}$

punti di accumulazione $-1 \leq x \leq 1 \vee x \geq \sqrt{5}$

punti isolati $x = 2$ $FE = \left\{-1, 1, 2, \sqrt{5}\right\}$

3) *E è un insieme né aperto né chiuso*

e) 1) 

2) *punti interni* $x < -1 \vee 0 < x < \sqrt{3} \vee \sqrt{3} < x < 2$

punti di accumulazione $x \leq -1 \vee 0 \leq x \leq 2$

punti isolati nessuno $FE = \left\{-1, 0, \sqrt{3}, 2\right\}$

3) *E è un insieme né aperto né chiuso*]

22. pag. 17

$$\left[\textit{Ad esempio}\colon E=\{x\in\mathbb{R}|x=\frac{1}{n},\ n\in\mathbb{N}^*\}\right]$$

23. pag. 17

[*Ad esempio*: *qualsiasi intervallo* (*limitato o illimitato*) *come* $E=(-2,6]$ *oppure* $E=(-\infty,\sqrt{2})$]

24. pag. 17

[*Tutti i punti di A*; $x=3$; $x\in\mathbb{N}-\{0,1,2\}$]

25. pag. 17

$$\left[\textit{Ad esempio}\colon E=[-2,-1)\cup\{0\}\cup\left(\frac{1}{2},\sqrt{3}\right)\right]$$

26. pag. 17

[*Ad esempio*: $[-1,0)\cup\{2,3\}$ *oppure lo stesso insieme dell'es.* 25]

27. pag. 17

$$\left[x=\frac{1}{2}\vee x=1\right]$$

28. pag. 17

[$x=5$]

29. pag. 17

[*Ad esempio*: $A=\{-2\}\cup(-1,5]$ *e* $B=(5,7]\cup(10,+\infty)$]

30. pag. 17

[$-3\le x\le 1$; $2\le x\le 7$; $0\le x\le 2$]

1. pag. 30

$$\left[\frac{1}{4};\ 1;\ 2;\ \frac{1}{8};\ \frac{1}{4};\ 1;\ \frac{1}{2};\ 2^{|\alpha|-2};\ 1\right]$$

2. pag. 30

$$\left[0;\ \frac{\alpha^3-1}{\alpha};\ \frac{\alpha(\alpha^2+3\alpha+3)}{\alpha+1};\ \frac{\alpha^3-3\alpha^2+3\alpha-2}{\alpha-1};\ \frac{8\alpha^3-1}{\alpha};\ \frac{t}{t^3-1};\ \frac{1-t^3}{t^2}\right]$$

4. pag. 30

[*a*) *no*; *b*) *no*; *c*) *sì*; *d*) *sì*; *e*) *no*; *f*) *sì*; *g*) *no*; *h*) *sì*]

5. pag. 30

[*a*) *algebriche razionali intere*; *b*) *algebriche razionali fratte*; *c*) *algebriche irrazionali*; *d*), *e*) *trascendenti logaritmiche*; *f*) *trascendenti esponenziali*; *g*) *trascendenti goniometriche*; *h*) *trascendenti di vario tipo*]

6. pag. 30

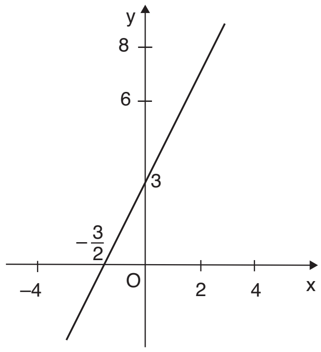
[$y=x^3$]

7. pag. 30

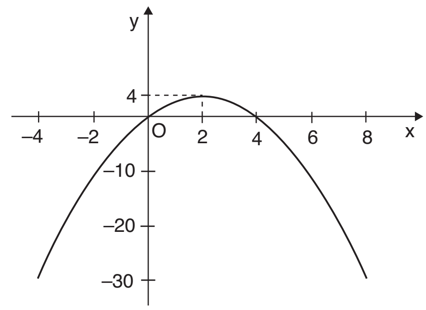
[*Le prime due e l'ultima*]

8. pag. 36 *Attenzione! Alcuni grafici sono in doppia scala.*

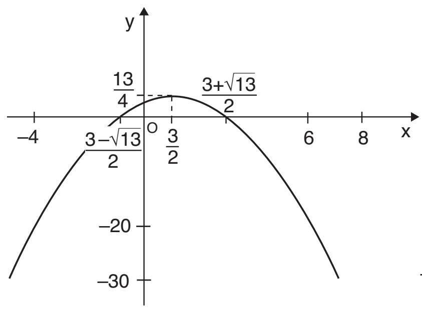
a)



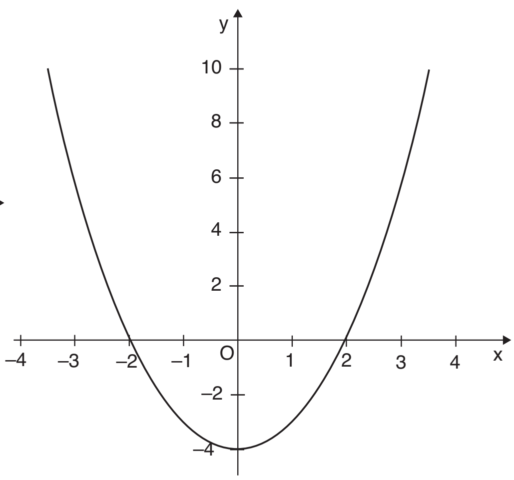
$f(x) = 2x + 3$



$f(x) = 4x - x^2$

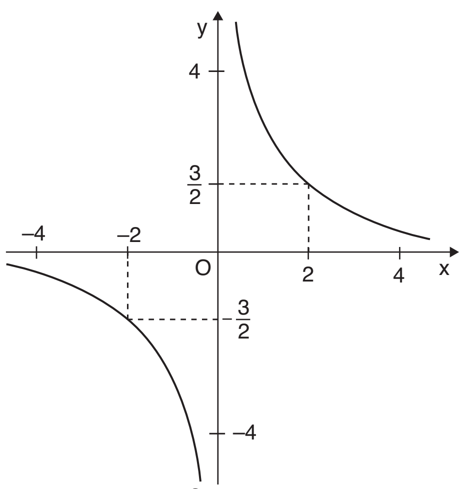


$f(x) = 3x - x^2 + 1$

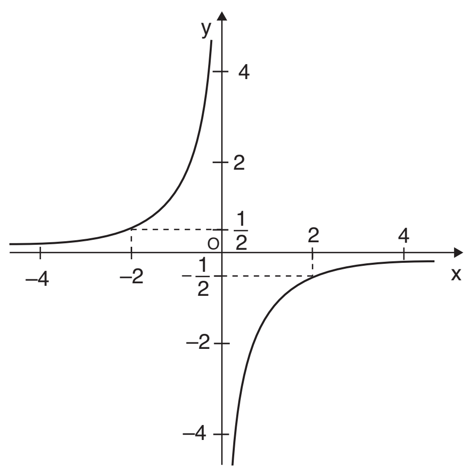


$f(x) = x^2 - 4$

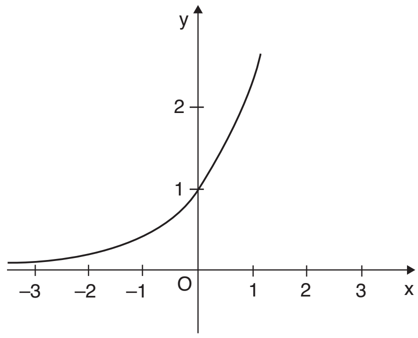
b)



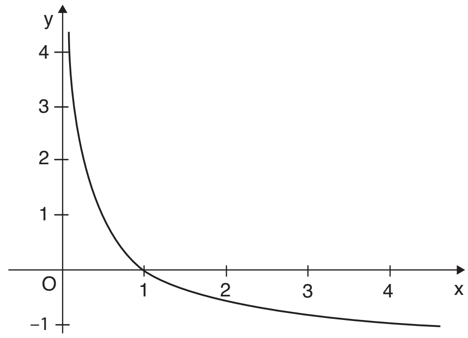
$f(x) = \frac{3}{x}$



$f(x) = -\frac{1}{x}$

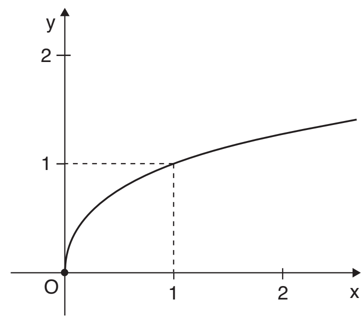


$f(x) = 3^x$

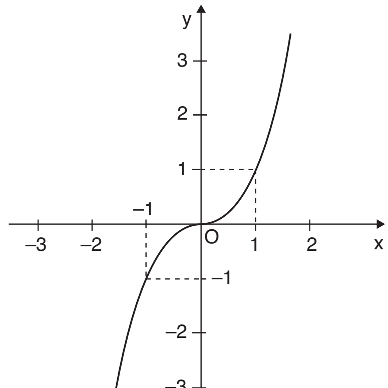


$f(x) = \log_{\frac{1}{4}} x$

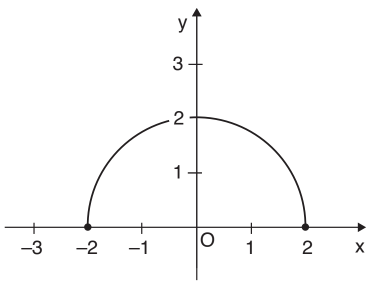
c)



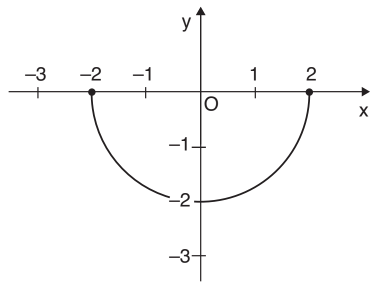
$f(x) = \sqrt{x}$



$f(x) = x^3$

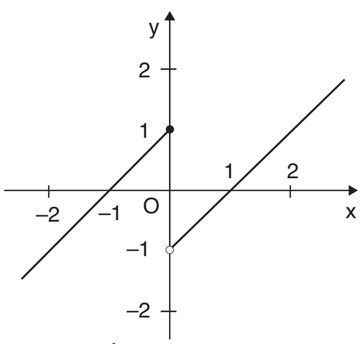


$f(x) = \sqrt{4 - x^2}$

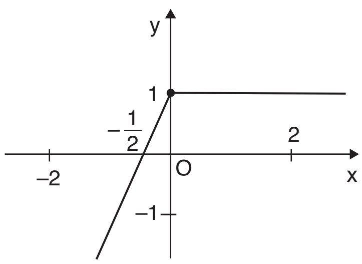


$f(x) = -\sqrt{4 - x^2}$

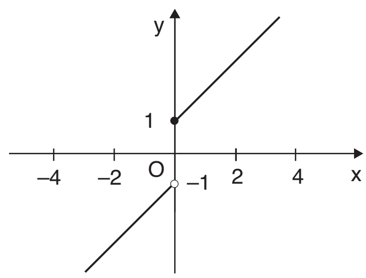
d)



$$f(x) = \begin{cases} x + 1 & \textit{per} \;\; x \leq 0 \\ x - 1 & \textit{per} \;\; x > 0 \end{cases}$$

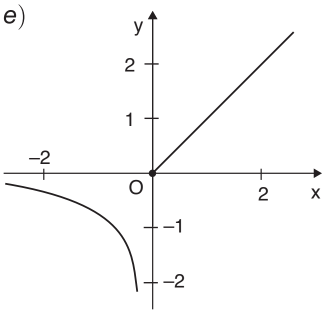


$$f(x) = \begin{cases} 2x + 1 & \textit{per } x \leq 0 \\ 1 & \textit{per } x > 0 \end{cases}$$

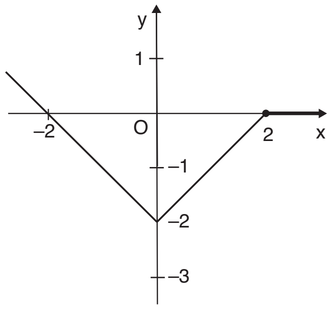


$$f(x) = \begin{cases} \dfrac{\sqrt{x^2}}{x} + x & \textit{per } x \neq 0 \\ 1 & \textit{per } x = 0 \end{cases}$$

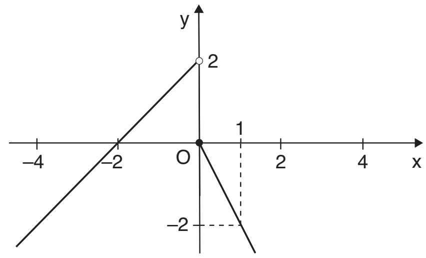
e)



$$f(x) = \begin{cases} \dfrac{1}{x} & \textit{per } x < 0 \\ |x| & \textit{per } x \geq 0 \end{cases}$$

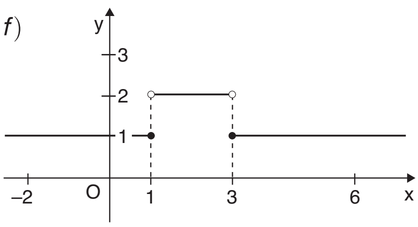


$$f(x) = \begin{cases} |x| - 2 & \textit{per } x \leq 2 \\ 0 & \textit{per } x > 2 \end{cases}$$

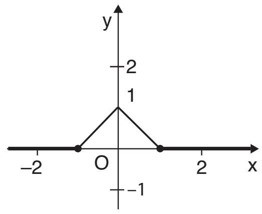


$$f(x) = \begin{cases} x + 2 & \textit{per } x < 0 \\ 0 & \textit{per } x = 0 \\ -2x & \textit{per } x > 0 \end{cases}$$

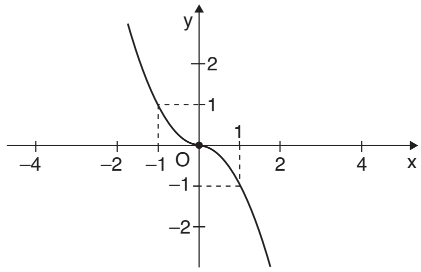
f)



$$f(x) = \begin{cases} 1 & \textit{per } x \leq 1 \vee x \geq 3 \\ 2 & \textit{per } 1 < x < 3 \end{cases}$$

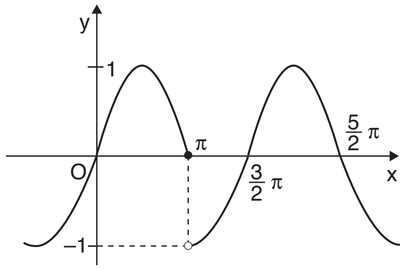


$$f(x) = \begin{cases} 1 - |x| & \textit{per } |x| \leq 1 \\ 0 & \textit{per } |x| > 1 \end{cases}$$

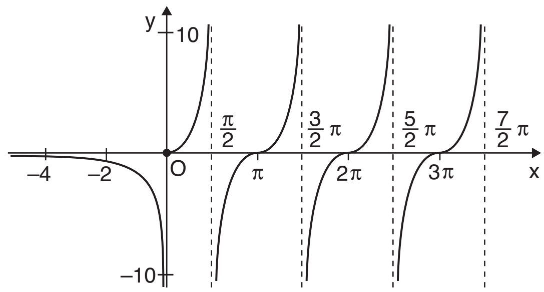


$$f(x) = \begin{cases} x^2 & \textit{per } x \leq 0 \\ -x^2 & \textit{per } x > 0 \end{cases}$$

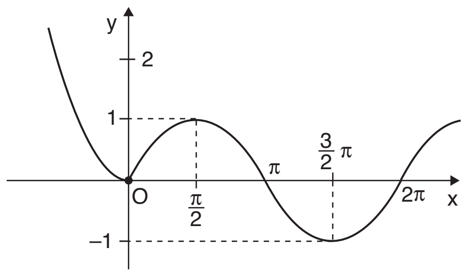
g)



$$f(x) = \begin{cases} \text{sen } x & \textit{per } x \leq \pi \\ \cos x & \textit{per } x > \pi \end{cases}$$

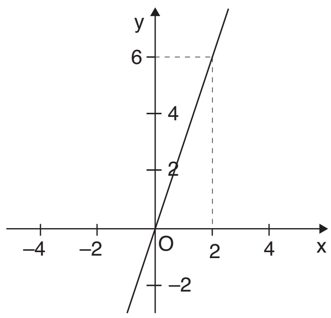


$$f(x) = \begin{cases} \dfrac{1}{x} & \textit{per } x < 0 \\ \text{tg } x & \textit{per } x \geq 0 \end{cases}$$

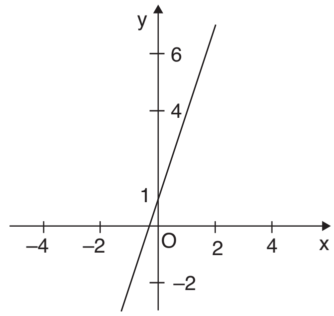


$$f(x) = \begin{cases} x^2 & \textit{per } x \leq 0 \\ \text{sen } x & \textit{per } x > 0 \end{cases}$$

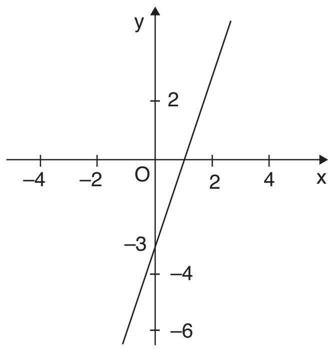
9. pag. 36



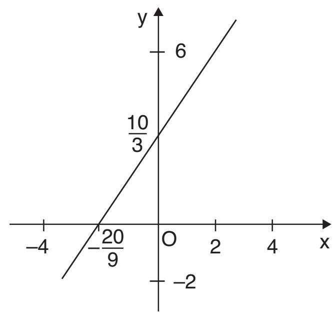
$f(x) = 3x$



$f(x) = 3x + 1$

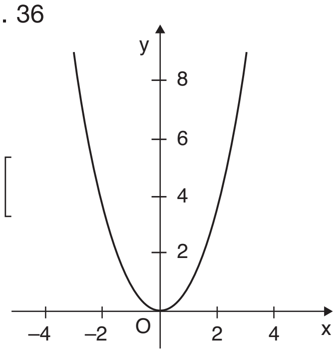


$f(x) = 3(x - 1)$

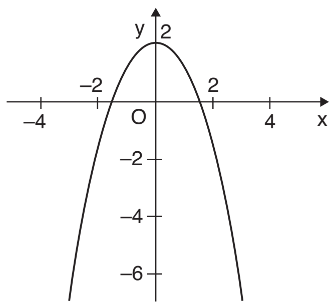


$f(x) = \frac{3}{2}(x + 2) + \frac{1}{3}$

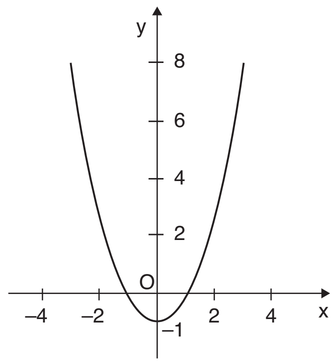
10. pag. 36



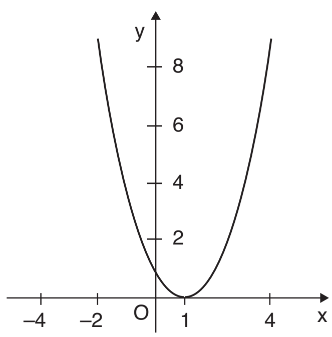
$f(x) = x^2$



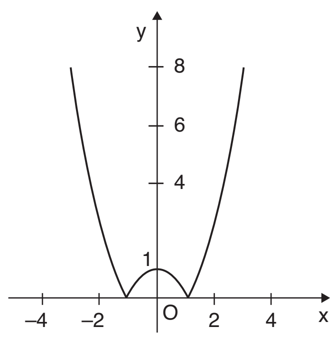
$f(x) = -x^2 + 2$



$f(x) = x^2 - 1$

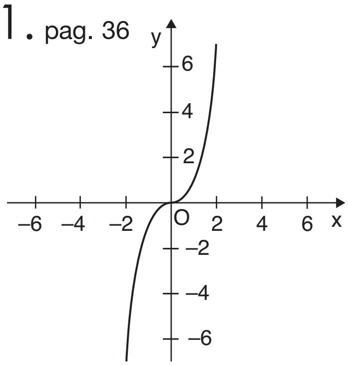


$f(x) = (x - 1)^2$

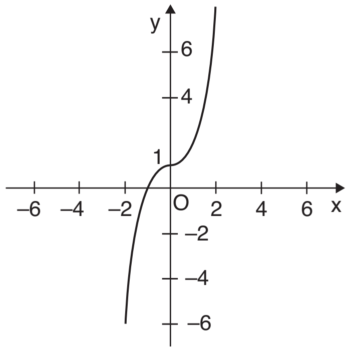


$f(x) = |x^2 - 1|$

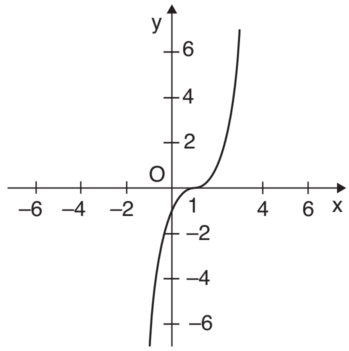
11. pag. 36



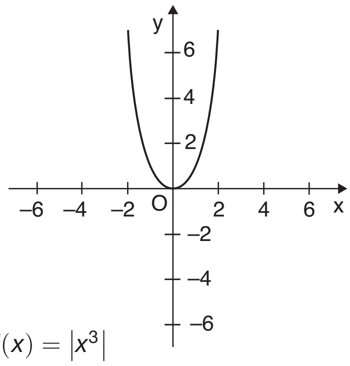
$f(x) = x^3$



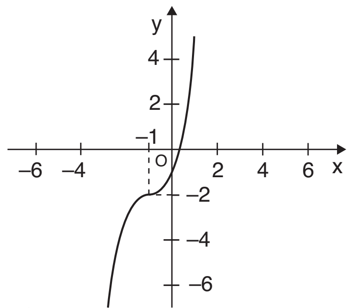
$f(x) = x^3 + 1$



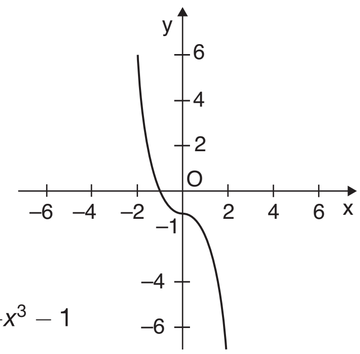
$f(x) = (x - 1)^3$



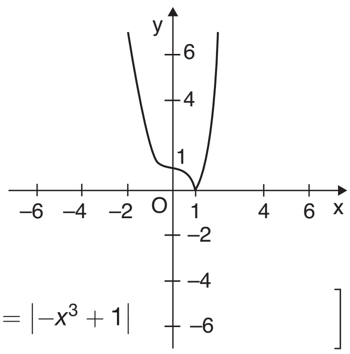
$f(x) = |x^3|$



$f(x) = (x + 1)^3 - 2$

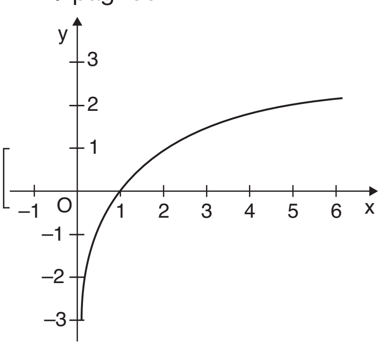


$f(x) = -x^3 - 1$

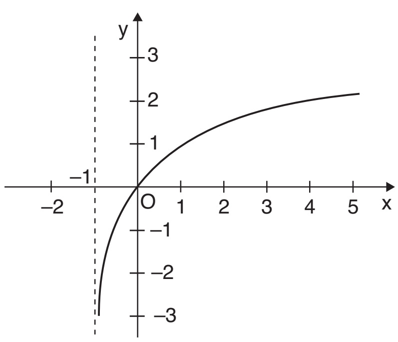


$f(x) = |-x^3 + 1|$

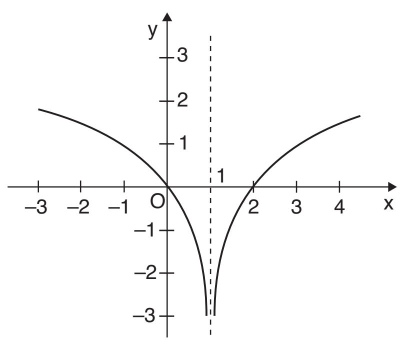
12. pag. 36



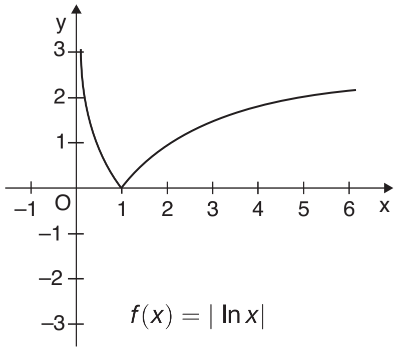
$f(x) = \ln x$



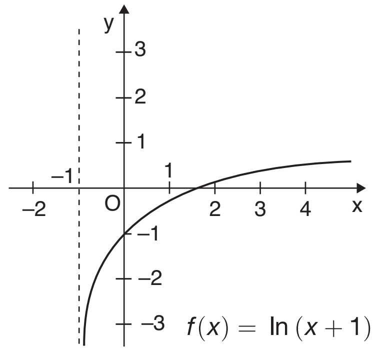
$f(x) = \ln (x + 1)$



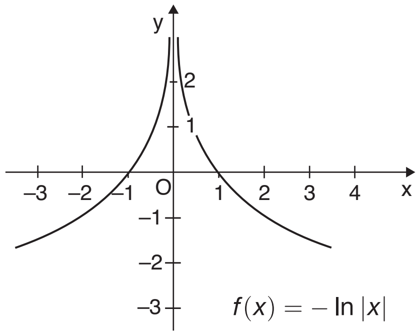
$f(x) = \ln |x - 1|$



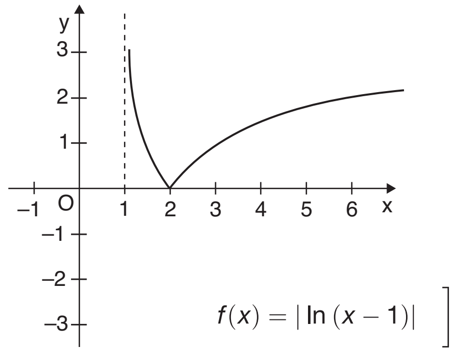
$f(x) = |\ln x|$



$f(x) = \ln(x+1) - 1$

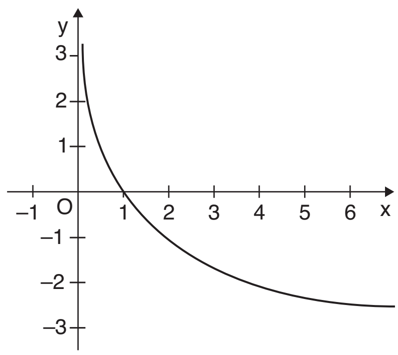


$f(x) = -\ln|x|$

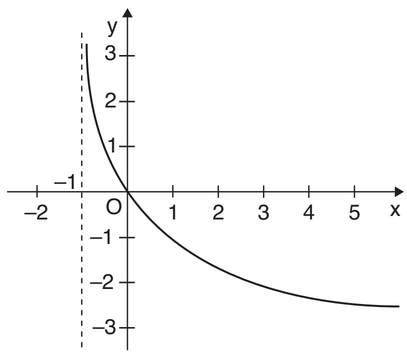


$f(x) = |\ln(x-1)|$

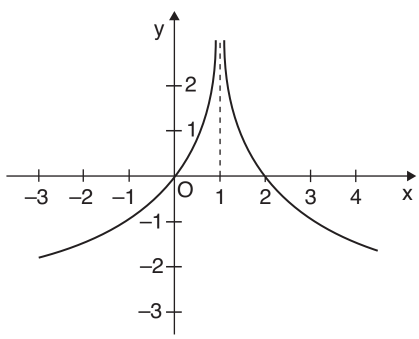
13. pag. 36



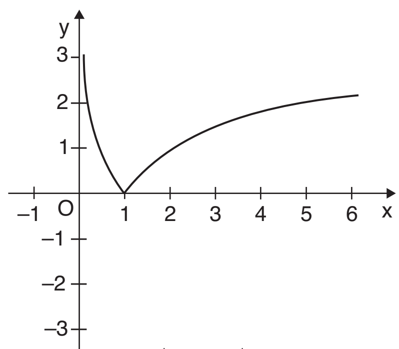
$f(x) = \log_{\frac{1}{2}} x$



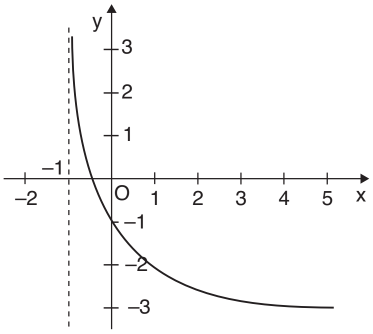
$f(x) = \log_{\frac{1}{2}}(x+1)$



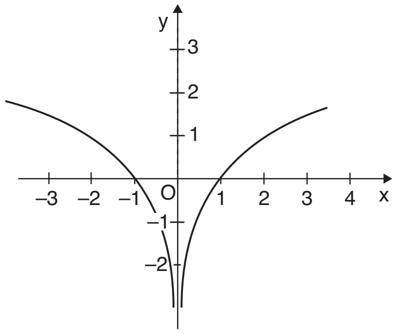
$f(x) = \log_{\frac{1}{2}}|x-1|$



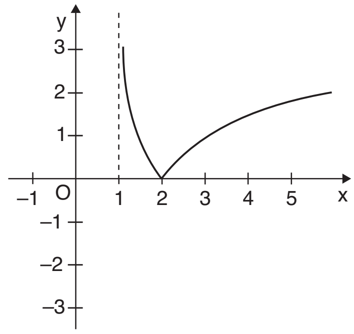
$f(x) = \left|\log_{\frac{1}{2}} x\right|$



$f(x) = \log_{\frac{1}{2}}(x+1) - 1$



$f(x) = -\log_{\frac{1}{2}}|x|$



$f(x) = \left|\log_{\frac{1}{2}}(x-1)\right|$

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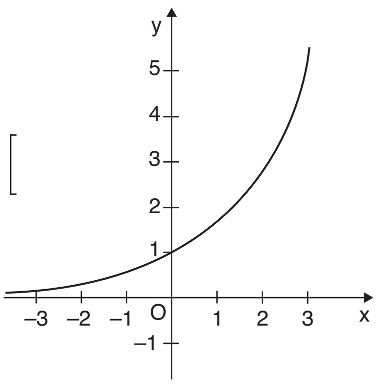
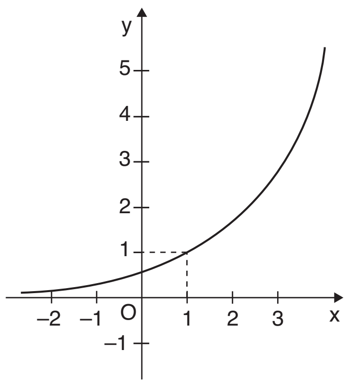
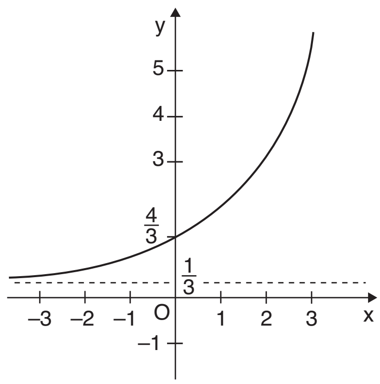


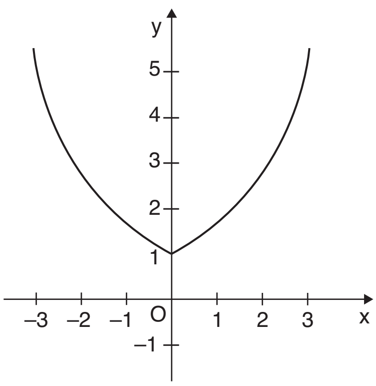
$f(x) = 2^x$



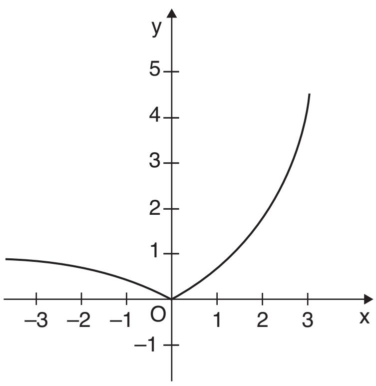
$f(x) = 2^{(x-1)}$



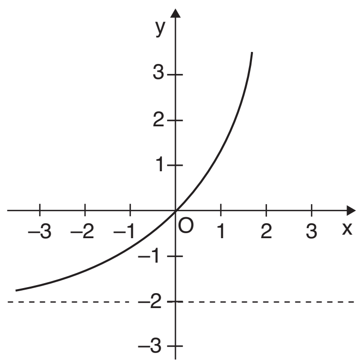
$f(x) = \frac{1}{3} + 2^x$



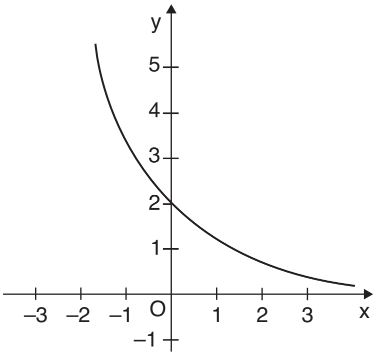
$f(x) = 2^{|x|}$



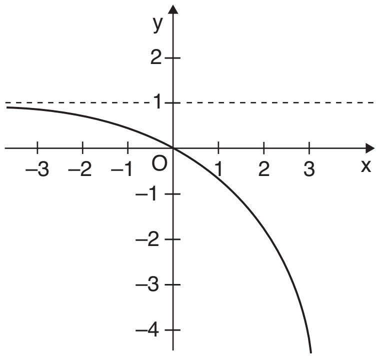
$f(x) = |2^x - 1|$



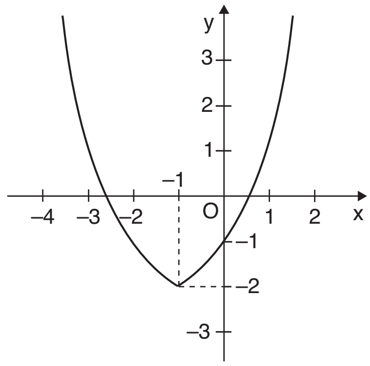
$f(x) = 2^{(x+1)} - 2$



$f(x) = 2^{(-x+1)}$



$f(x) = 1 - 2^x$



$f(x) = 2^{|x+1|} - 3$

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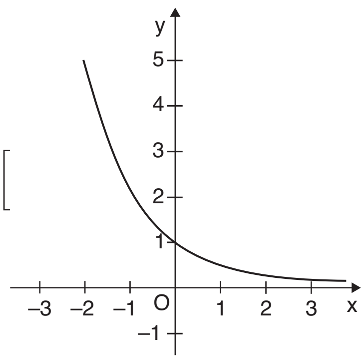
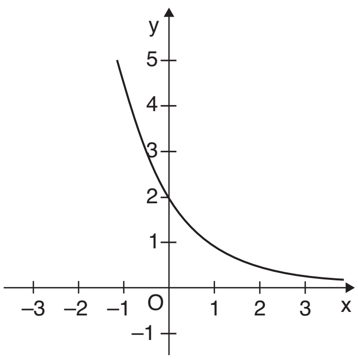
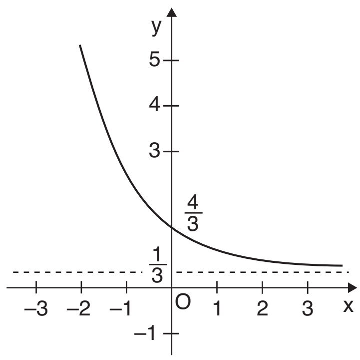


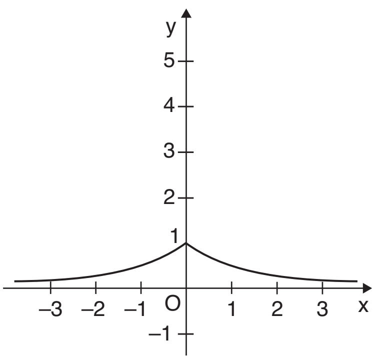
$f(x) = \left(\frac{1}{2}\right)^x$



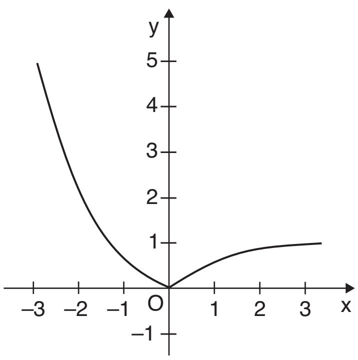
$f(x) = \left(\frac{1}{2}\right)^{(x-1)}$



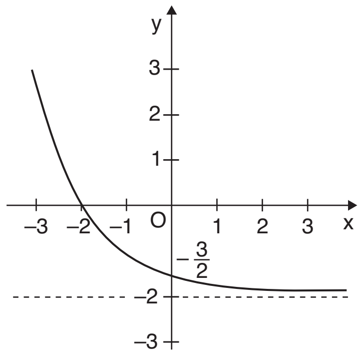
$f(x) = \frac{1}{3} + \left(\frac{1}{2}\right)^x$



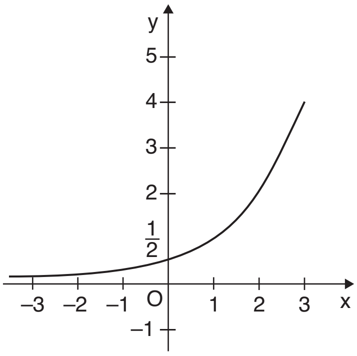
$f(x) = \left(\frac{1}{2}\right)^{|x|}$

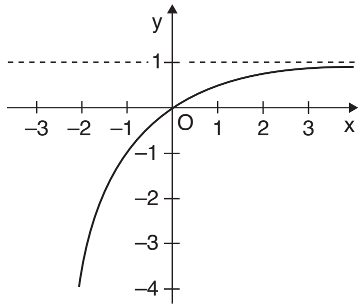


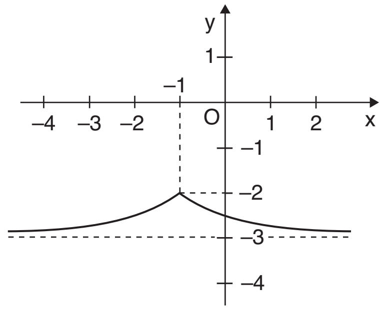
$f(x) = \left|\left(\frac{1}{2}\right)^x - 1\right|$



$f(x) = \left(\frac{1}{2}\right)^{(x+1)} - 2$



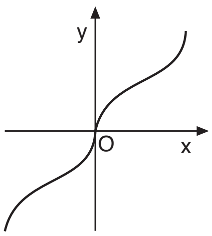




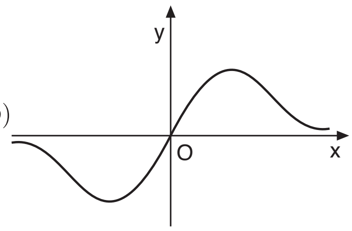
$f(x) = \left(\frac{1}{2}\right)^{(-x+1)}$ $\qquad f(x) = 1 - \left(\frac{1}{2}\right)^{x}$ $\qquad f(x) = \left(\frac{1}{2}\right)^{|x+1|} - 3$

25. pag. 40

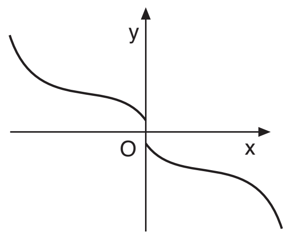
a)



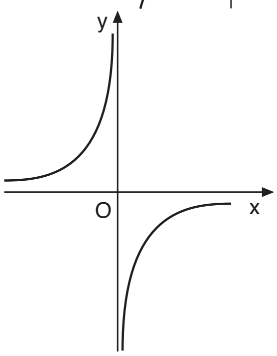
b)



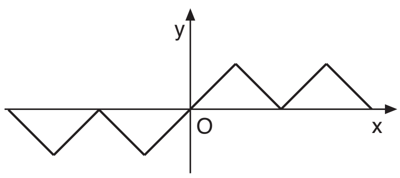
c)



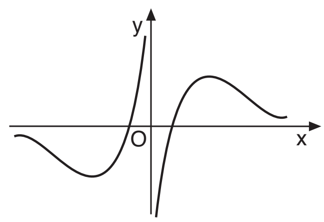
d)



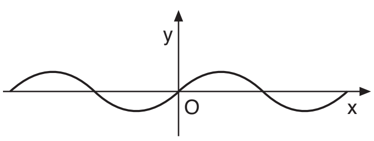
e)



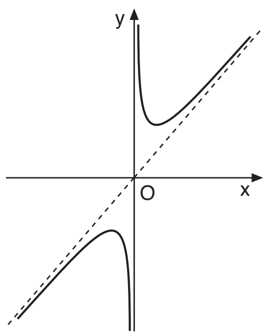
f)



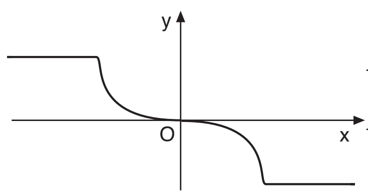
g)



h)

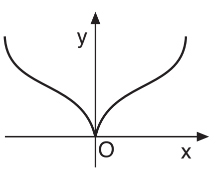


i)

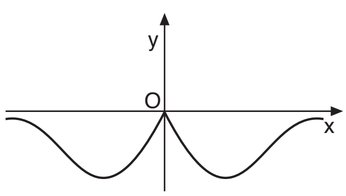


26. pag. 40

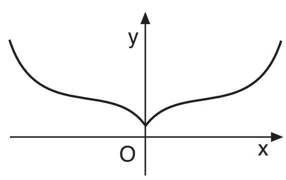
a)



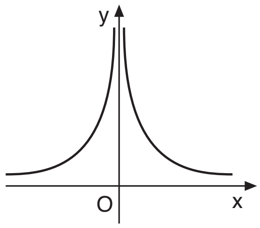
b)



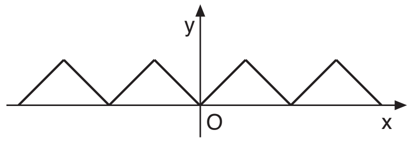
c)



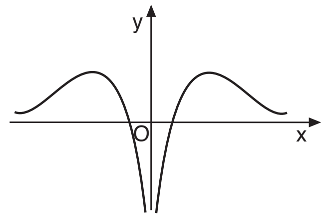
d)



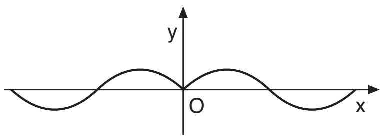
e)



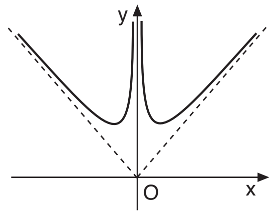
f)



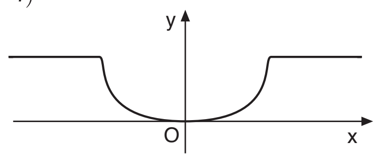
g)



h)



i)



]

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[*a*) $D=\mathbb{R}$; *b*) *funzione né pari, né dispari*; *c*) $f(x)$ *iniettiva in*: $(-\infty,-1]$ *e in*: $[-1,0]$ *e in*: $[0,1]$ *e in*: $[1,+\infty)$; *d*) $f(D)=(-\infty,2]$; *e*) $f(x)$ *non è suriettiva poiché* $f(D)\subset\mathbb{R}$; *f*) $\sup f(x)=2=M$, $x_M=1$; $\inf f(x)=-\infty$, $\nexists m$;
g) *asse x*: $P_1(0,0)\vee P_2\left(\frac{9}{2},0\right)$, *asse y*: $P_1(0,0)$;
h) $f(x)>0$: $(-\infty,0)\cup\left(0,\frac{9}{2}\right)$, $f(x)<0$: $\left(\frac{9}{2},+\infty\right)$;
i) $f(x)$ *crescente in*: $(-\infty,-1]$ *e in*: $[0,1]$, $f(x)$ *decrescente in*: $[-1,0]$ *e in*: $[1,+\infty)$]

49. pag. 48

[*a*) $D=\mathbb{R}$; *b*) *funzione né pari, né dispari*; *c*) $f(x)$ *iniettiva in*: $(-\infty,1]$ *e in*: $[1,+\infty)$;
d) $f(D)=\left[-\frac{1}{2},+\infty\right)$; *e*) $f(x)$ *non è suriettiva poiché* $f(D)\subset\mathbb{R}$; *f*) $\sup f(x)=+\infty$, $\nexists M$;
$\inf f(x)=-\frac{1}{2}=m$, $x_m=1$; *g*) *asse x*: $P_1(0,0)\vee P_2\left(\frac{4}{3},0\right)$, *asse y*: $P_1(0,0)$;
h) $f(x)>0$: $(-\infty,0)\cup\left(\frac{4}{3},+\infty\right)$, $f(x)<0$: $\left(0,\frac{4}{3}\right)$;
i) $f(x)$ *crescente in*: $[1,+\infty)$, $f(x)$ *decrescente in*: $(-\infty,1]$]

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[*a*) $D=\mathbb{R}$; *b*) *funzione pari*; *c*) $f(x)$ *iniettiva in*: $(-\infty,-1]$ *e in*: $[-1,0]$ *e in*: $[0,1]$ *e in*: $[1,+\infty)$;
d) $f(D)=\left[-\frac{5}{2},+\infty\right)$; *e*) $f(x)$ *non è suriettiva poiché* $f(D)\subset\mathbb{R}$; *f*) $\sup f(x)=+\infty$, $\nexists M$;
$\inf f(x)=-\frac{5}{2}=m$, $x_m=-1\vee x_m=1$;
g) *asse x*: $P_1\left(-\frac{4}{3},0\right)\vee P_2\left(-\frac{1}{2},0\right)\vee P_3\left(\frac{1}{2},0\right)\vee P_4\left(\frac{4}{3},0\right)$, *asse y*: $Q_1(0,4)$;
h) $f(x)>0$: $\left(-\infty,-\frac{4}{3}\right)\cup\left(-\frac{1}{2},\frac{1}{2}\right)\cup\left(\frac{4}{3},+\infty\right)$, $f(x)<0$: $\left(-\frac{4}{3},-\frac{1}{2}\right)\cup\left(\frac{1}{2},\frac{4}{3}\right)$;
i) $f(x)$ *crescente in*: $[-1,0]$ *e in*: $[1,+\infty)$, $f(x)$ *decrescente in*: $(-\infty,-1]$ *e in*: $[0,1]$]

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[*a*) $D=\left(-\infty,\frac{1}{2}\right)\cup\left(\frac{1}{2},2\right)\cup(2,+\infty)$; *b*) *funzione né pari, né dispari*;

$c)$ *$f(x)$ iniettiva in*: $(-\infty,-1]$ *e in*: $\left[-1,\frac{1}{2}\right)$ *e in*: $\left(\frac{1}{2},1\right]$ *e in*: $[1,2)$ *e in*: $(2,+\infty)$;

$d)$ $f(D)=(-\infty,-2]\cup\left[\frac{2}{9},+\infty\right)$; $e)$ *$f(x)$ non è suriettiva poiché $f(D)\subset\mathbb{R}$*;

$f)$ $\sup f(x)=+\infty$, $\nexists M$; $\inf f(x)=-\infty$, $\nexists m$; $g)$ *asse x: nessuna intersezione, asse y*: $Q_1\left(0,\frac{1}{2}\right)$;

$h)$ $f(x)>0$: $\left(-\infty,\frac{1}{2}\right)\cup(2,+\infty)$, $f(x)<0$: $\left(\frac{1}{2},2\right)$; $i)$ *$f(x)$ crescente in*: $\left[-1,\frac{1}{2}\right)$ *e in*: $\left(\frac{1}{2},1\right]$,

$f(x)$ decrescente in: $(-\infty,-1]$ *e in*: $[1,2)$ *e in*: $(2,+\infty)$]

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[*In relazione all'esercizio 44 a) pag. 47, si ha*:

$b)$ *funzione né pari, né dispari*; $c)$ *$f(x)$ iniettiva in*: $\left(-\infty,-\frac{3}{2}\right]$ *e in*: $\left[-\frac{3}{2},\frac{3}{2}\right]$ *e in*: $\left[\frac{3}{2},+\infty\right)$;

$e)$ *$f(x)$ non è suriettiva poiché $f(D)\subset\mathbb{R}$*; $f)$ $\sup f(x)=+\infty$, $\nexists M$; $\inf f(x)=-1=m$, $x_m=-\frac{3}{2}$;

$g)$ *asse x*: $P_1(-2,0)\vee P_2(0,0)$, *asse y*: $P_2(0,0)$; $h)$ $f(x)>0$: $(-\infty,-2)\cup(0,+\infty)$, $f(x)<0$: $(-2,0)$;

$i)$ *$f(x)$ crescente in*: $\left[-\frac{3}{2},\frac{3}{2}\right]$, *$f(x)$ decrescente in*: $\left(-\infty,-\frac{3}{2}\right]$ *e in*: $\left[\frac{3}{2},+\infty\right)$.

In relazione all'esercizio 44 b) pag. 47, si ha:

$b)$ *funzione né pari, né dispari*; $c)$ *$f(x)$ iniettiva in*: $(-\infty,0]$; $e)$ *$f(x)$ non è suriettiva poiché $f(D)\subset\mathbb{R}$*;
$f)$ $\sup f(x)=2=M$, $x_M=\{x\in\mathbb{R}|x\geq 0\}$; $\inf f(x)=-\infty$, $\nexists m$;
$g)$ *asse x*: $P_1(-2,0)$, *asse y*: $Q_1(0,2)$; $h)$ $f(x)>0$: $(-2,+\infty)$, $f(x)<0$: $(-\infty,-2)$;
$i)$ *$f(x)$ crescente in*: $(-\infty,0]$, *$f(x)$ non decrescente in D*.

In relazione all'esercizio 45 a) pag. 47, si ha:

$b)$ *funzione né pari, né dispari*; $c)$ *$f(x)$ iniettiva in*: $[-7,-4]$ *e in*: $[-4,0)$ *e in*: $(0,2]$ *e in*: $[2,6]$;
$e)$ *$f(x)$ è suriettiva poiché $f(D)=\mathbb{R}$*; $f)$ $\sup f(x)=+\infty$, $\nexists M$; $\inf f(x)=-\infty$, $\nexists m$;

$g)$ *asse x*: $P_1(-7,0)\vee P_2\left(-\frac{5}{3},0\right)\vee P_3(1,0)\vee P_4(5,0)$, *asse y: nessuna intersezione*;

$h)$ $f(x)>0$: $\left(-7,-\frac{5}{3}\right)\cup(0,1)\cup(5,6]$, $f(x)<0$: $\left(-\frac{5}{3},0\right)\cup(1,5)$;

$i)$ *$f(x)$ crescente in*: $[-7,-4]$ *e in*: $[2,6]$, *$f(x)$ decrescente in*: $[-4,0)$ *e in*: $(0,2]$.

In relazione all'esercizio 45 b) pag. 47, si ha:

$b)$ *funzione né pari, né dispari*; $c)$ $f(x)$ iniettiva in D; $e)$ *$f(x)$ non è suriettiva poiché $f(D)\subset\mathbb{R}$*;
$f)$ $\sup f(x)=+\infty$, $\nexists M$; $\inf f(x)=0$, $\nexists m$; $g)$ *asse x: nessuna intersezione*, asse y: *nessuna intersezione*;
$h)$ $f(x)>0$: D, $f(x)<0$: $\emptyset$; $i)$ $f(x)$ crescente in D.

In relazione all'esercizio 46 a) pag. 47, si ha:

$b)$ *funzione né pari, né dispari*; $c)$ *$f(x)$ iniettiva in*: $[-5,-1)$ *e in*: $[-1,4)$;
$e)$ *$f(x)$ non è suriettiva poiché $f(D)\subset\mathbb{R}$*; $f)$ $\sup f(x)=+\infty$, $\nexists M$; $\inf f(x)=-4=m$, $x_m=-1$;
$g)$ *asse x*: $P_1(-5,0)$, *asse y*: $Q_1(0,-2)$; $h)$ $f(x)>0$: $(-5,-1)$, $f(x)<0$: $[-1,4)$;
$i)$ *$f(x)$ crescente in*: $[-5,-1)$ *e in*: $[-1,4)$, *$f(x)$ decrescente in nessun sottoinsieme di D.*

In relazione all'esercizio 46 b) pag. 47, si ha:

$b)$ *funzione né pari, né dispari*; $c)$ *$f(x)$ iniettiva in*: $(-\infty,-3]$ *e in*: $[-3,0]$ *e in*: $[0,1]$ *e in*: $[1,2)$;

$e)$ *$f(x)$ non è suriettiva poiché $f(D)\subset\mathbb{R}$*; $f)$ $\sup f(x)=+\infty$, $\nexists M$; $\inf f(x)=-\frac{3}{2}=m$, $x_m=1$;

g) *asse x*: $P_1\left(\frac{1}{2},0\right) \vee P_2\left(\frac{3}{2},0\right)$, *asse y*: $Q_1(0,3)$; *h*) $f(x) > 0$: $\left(-\infty,\frac{1}{2}\right) \cup \left(\frac{3}{2},2\right)$, $f(x) < 0$: $\left(\frac{1}{2},\frac{3}{2}\right)$;
i) $f(x)$ *crescente in*: $[-3,0]$ *e in*: $[1,2)$, $f(x)$ *decrescente in*: $(-\infty,-3]$ *e in*: $[0,1]$.

In relazione all'esercizio 47 *a*) *pag.* 47, *si ha*:
b) *funzione né pari, né dispari*; *c*) $f(x)$ *iniettiva in*: $(-\infty,-3]$ *e in*: $[-3,-1]$ *e in*: $[-1,0)$ *e in*: $(0,+\infty)$;
e) $f(x)$ *non è suriettiva poiché* $f(D) \subset \mathbb{R}$; *f*) $\sup f(x) = 2$, $\nexists M$; $\inf f(x) = -\infty$, $\nexists m$;
g) *asse x*: $P_1(-4,0) \vee P_2(-2,0) \vee P_3\left(-\frac{1}{2},0\right)$, *asse y*: *nessuna intersezione*;
h) $f(x) > 0$: $(-\infty,-4) \cup \left(-2,-\frac{1}{2}\right) \cup (0,+\infty)$, $f(x) < 0$: $(-4,-2) \cup \left(-\frac{1}{2},0\right)$;
i) $f(x)$ *crescente in*: $[-3,-1]$ *e in*: $(0,+\infty)$, $f(x)$ *decrescente in*: $(-\infty,-3]$ *e in*: $[-1,0)$.

In relazione all'esercizio 47 *b*) *pag.* 47, *si ha*:
b) *funzione né pari, né dispari*; *c*) $f(x)$ *iniettiva in*: $\left(-\frac{7}{3},1\right]$ *e in*: $[1,3)$ *e in*: $(3,+\infty)$;
e) $f(x)$ *è suriettiva poiché* $f(D) = \mathbb{R}$; *f*) $\sup f(x) = +\infty$, $\nexists M$; $\inf f(x) = +\infty$, $\nexists m$;
g) *asse x*: $P_1(0,0) \vee P_2(2,0)$, *asse y*: $P_1(0,0)$; *h*) $f(x) > 0$: $\left(-\frac{7}{3},0\right) \cup (2,3)$, $f(x) < 0$: $(0,2) \cup (3,+\infty)$;
i) $f(x)$ *crescente in*: $[1,3)$ *e in*: $(3,+\infty)$, $f(x)$ *decrescente in*: $\left(-\frac{7}{3},1\right]$]

53. pag. 49

[*Si ha*: $h(x) = (\text{sen } x)^2 = \text{sen}^2 x$, $k(x) = \text{sen}(x^2)$;
$h(x) = \ln(x^2-1)$, $k(x) = (\ln x)^2 - 1 = \ln^2 x - 1$; $h(x) = 2^{2x}$, $k(x) = 2^{x^2}$]

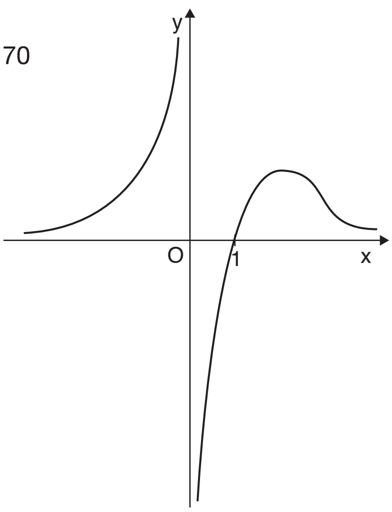
54. pag. 49

[*Si ha*: $h(x) = \text{sen}(3x+1)$, $k(x) = 3\,\text{sen}\,x + 1$;
$h(x) = \sqrt{\ln x}$, $k(x) = \ln\sqrt{x} = \frac{1}{2}\ln x$; $h(x) = \frac{1}{x^2-x+1}$, $k(x) = \frac{1}{x^2} - \frac{1}{x} + 1$]

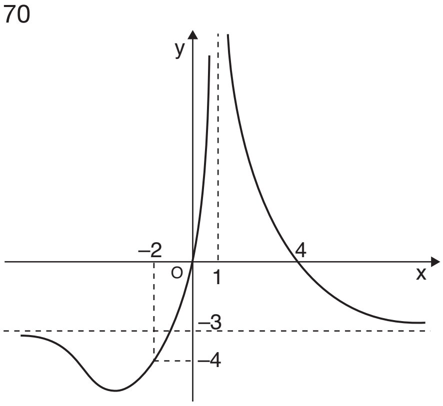
55. pag. 49

[*Si ha*: $h(x) = \log\frac{1+x}{1-x}$, $k(x) = \frac{1+\log x}{1-\log x}$; $h(x) = e^{\text{sen}x+1}$, $k(x) = \text{sen}\,e^x + 1$;
$h(x) = 4x^2 + 2x - 6$, $k(x) = 2x^2 - 10x + 3$]

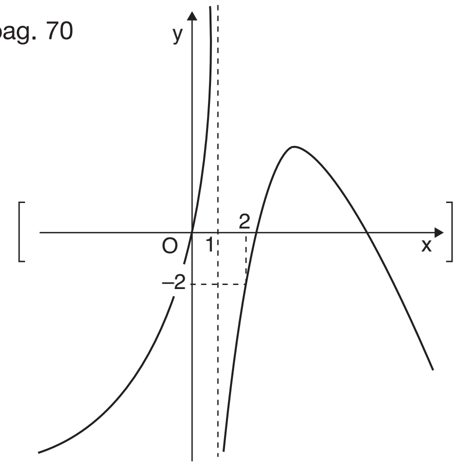
20. pag. 70

[]

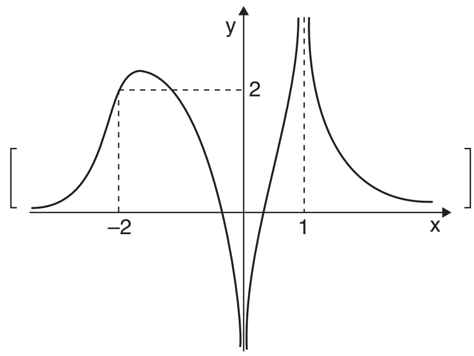
22. pag. 70

[]

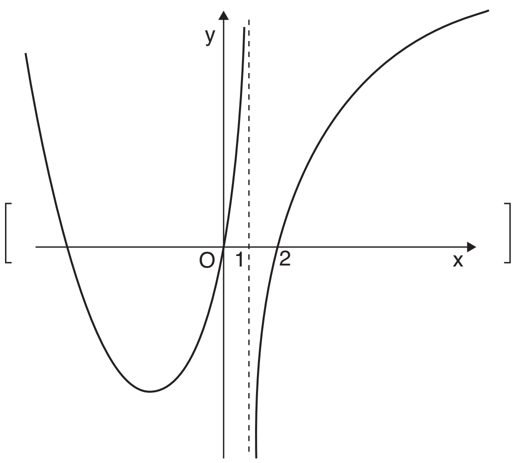
24. pag. 70



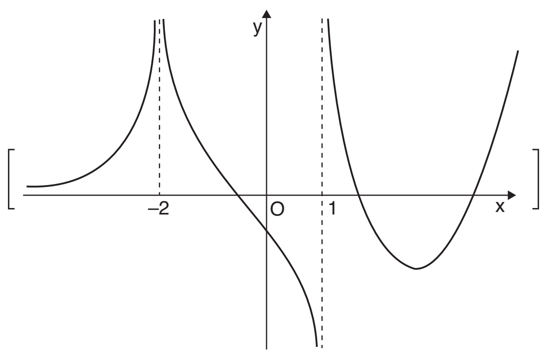
26. pag. 70



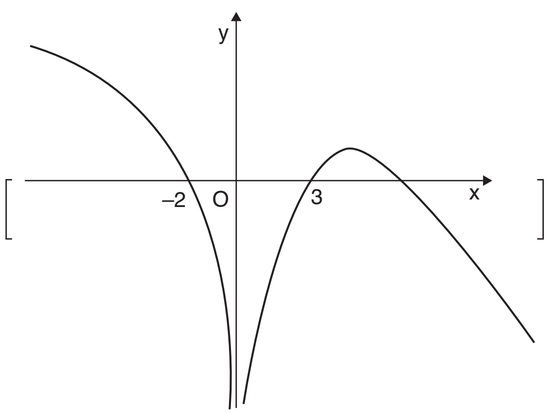
27. pag. 70



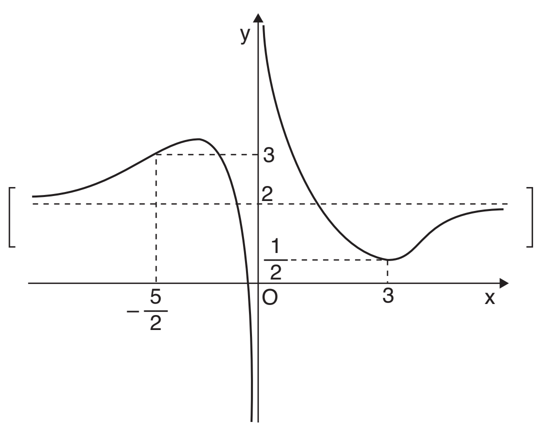
28. pag. 70



29. pag. 70



30. pag. 70



152. pag. 142

[$D = \mathbb{R}$; *continua e derivabile in tutto il dominio* D]

153. pag. 142

[$D = \mathbb{R}$; *continua e derivabile in tutto il dominio* D]

154. pag. 142

[$D = \mathbb{R}$; *continua in* $D - \{1\}$: $x = 1$ *punto di discontinuità di prima specie* (*ricordiamo che*: *nei punti in cui una funzione è definita ma non è continua, non può essere derivabile*); *derivabile in* $D - \{1\}$]

155. pag. 142

[$D = [-2, 2]$; *continua in tutto il dominio* D; *derivabile in* $D - \{-1, 0, 1\}$: $x = -1 \vee x = 0 \vee x = 1$: *punti angolosi*]

156. pag. 142

[$D = \mathbb{R}^+$; *continua in tutto il dominio* D; *derivabile in* $D - \{3\}$: $x = 3$ *punto angoloso*]

157. pag. 142

[$D = \mathbb{R}$; *continua in tutto il dominio* D; *derivabile in* $D - \{0\}$: $x = 0$ *punto di cuspide*]

158. pag. 142

[$D = \mathbb{R}$; *continua in tutto il dominio* D; *derivabile in* $D - \{-1\}$: $x = -1$ *punto angoloso*]

159. pag. 142

[$D = \mathbb{R} - \{2\}$; *continua in tutto il dominio* D: $x = 2$ *punto di discontinuità di terza specie*; *derivabile in* $D - \{-2\}$: $x = -2$ *punto di flesso a tangente verticale*]

160. pag. 143

[$D = [-4, -2) \cup (-2, 2) \cup (2, 4]$; *continua in tutto il dominio* D: $x = -2 \vee x = 2$ *punti di discontinuità di seconda specie*; *derivabile in tutto il dominio* D]

161. pag. 143

[$D = \mathbb{R} - \{1\}$; *continua in tutto il dominio* D: $x = 1$ *punto di discontinuità di seconda specie*; *derivabile in tutto il dominio* D]

Formulario

FORMULE DI GEOMETRIA ANALITICA PIANA

Coordinate cartesiane

- **Distanza** *d fra due punti* $P_1(x_1,\ y_1)$ *e* $P_2(x_2,\ y_2)$:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

- *Coordinate del* **punto medio** *M del segmento di estremi* $P_1(x_1,\ y_1)$ *e* $P_2(x_2,\ y_2)$:

$$x_M = \frac{x_1 + x_2}{2}, \qquad y_M = \frac{y_1 + y_2}{2}$$

- *Coordinate del* **baricentro** *G del triangolo di vertici* $P_1(x_1,\ y_1),\ P_2(x_2,\ y_2)$ *e* $P_3(x_3,\ y_3)$:

$$x_G = \frac{x_1 + x_2 + x_3}{3}, \qquad y_G = \frac{y_1 + y_2 + y_3}{3}$$

Retta

- *a)* *equazione* **generale**: $ax + by + c = 0,\ (a^2 + b^2 \neq 0)$
  b) *equazione* **esplicita**: $y = mx + q,$
  c) *equazione* **segmentaria**: $\frac{x}{p} + \frac{y}{q} = 1.$
- **Coefficiente angolare**:

$$m = -\frac{a}{b} = \frac{y_2 - y_1}{x_2 - x_1} = \operatorname{tg}\alpha.$$

- *Retta* **passante per due punti** $P_1(x_1,\ y_1),\ P_2(x_2,\ y_2)$:

$$\frac{x - x_1}{x_2 - x_1} = \frac{y - y_1}{y_2 - y_1}$$

- *Date due rette r, s di equazione generali*: $ax + by + c = 0, \quad a_1x + b_1x + c_1 = 0,$
  o di *equazione esplicite*: $y = mx + q, \quad y = m_1x + q_1$:

  Le due rette sono **parallele** se e soltanto se:

  (1) $ab_1 = a_1b$ *oppure*: $m = m_1$

  Le due rette sono **perpendicolari** se e soltanto se:

  (2) $aa_1 + bb_1 = 0$ *oppure*: $mm_1 = -1$

- *La retta* **parallela** *ad r e passante per* $P_1(x_1,\ y_1)$ *ha equazione*:

(3) $\boxed{a(x-x_1)+b(y-y_1)=0}$ *oppure*: $\boxed{y-y_1=m(x-x_1)}$

- *La retta* **perpendicolare** *ad r e passante per* $P_1(x_1,\ y_1)$ *ha equazione*:

(4) $\boxed{b(x-x_1)-a(y-y_1)=0}$ *oppure*: $\boxed{y-y_1=-\dfrac{1}{m}(x-x_1)}$

- *La* **distanza** (*assoluta*) *d del punto* $P_1(x_1,\ y_1)$ *dalla retta r è data da*:

(5) $\boxed{d=\dfrac{|ax_1+by_1+c|}{\sqrt{a^2+b^2}}}$ *oppure*: $\boxed{d=\dfrac{|mx_1-y_1+q|}{\sqrt{m^2+1}}}$

Osservazione

Le formule (1), (2), (3), (4) scritte a sinistra sono valide *qualunque* siano le rette date, mentre quelle di destra esigono che nessuna delle rette in questione risulti parallela all'asse *y*.

- **Area del triangolo** *di vertici* $P_1(x_1,\ y_1),\ P_2(x_2,\ y_2),\ P_3(x_3,\ y_3)$:

$$A=\pm\frac{1}{2}\begin{vmatrix} x_3-x_1 & y_3-y_1 \\ x_2-x_1 & y_2-y_1 \end{vmatrix},\quad (\textit{si sceglie il segno, } + \textit{ o } -\textit{, per il quale risulta: } A\geq 0)$$

- **Bisettrici** *degli angoli formati dalle due rette*: $ax+by+c=0$ e $a_1x+b_1y+c_1=0$:

$$\frac{ax+by+c}{\sqrt{a^2+b^2}}=\pm\frac{a_1x+b_1y+c_1}{\sqrt{a_1^2+b_1^2}}.$$

- *L'***angolo** α **formato da due rette non perpendicolari** *e di equazioni* $y=mx+q$ *e* $y=m_1x+q_1$ *è dato da*:

$$\mathrm{tg}\,\alpha=\frac{m_1-m}{1+mm_1}.$$

Circonferenza

Circonferenza *di centro* $C(\alpha,\ \beta)$ *e raggio r*:

$$\boxed{(x-\alpha)^2+(y-\beta)^2=r^2,\quad \text{oppure}:\quad x^2+y^2+ax+by+c=0}$$

con:

$$\alpha=-\frac{a}{2},\quad \beta=-\frac{b}{2},\quad r=\sqrt{\left(\frac{a}{2}\right)^2+\left(\frac{b}{2}\right)^2-c},\quad \text{con}\quad \left(\frac{a}{2}\right)^2+\left(\frac{b}{2}\right)^2-c\geq 0.$$

- Se $P_1(x_1,\ y_1)$ sta sulla circonferenza $T: x^2+y^2+ax+by+c=0$, l'equazione della tangente in P_1 a T ha equazione:

$$x_1x+y_1y+a\frac{x+x_1}{2}+b\frac{y+y_1}{2}+c=0.$$

Ellisse

Ellisse *di centro O e fuochi* $F'(-c,\ 0),\ F(c,\ 0)$:

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1,\qquad \text{con}:\quad b^2=a^2-c^2.\quad \textit{Eccentricità}: e=\frac{c}{a}<1.$$

Iperbole

Iperbole *di centro O e fuochi* $F'(-c,\ 0),\ F(c,\ 0)$:

$$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1,\qquad \text{con}:\quad b^2=c^2-a^2.\quad \textit{Eccentricità}: e=\frac{c}{a}>1.$$

Asintoti: $y=\dfrac{b}{a}x$ e $y=-\dfrac{b}{a}x$,

- *Iperbole* **equilatera**: $x^2 - y^2 = a^2$. *Asintoti*: $y = \pm x$.
- *Iperbole equilatera* **riferita agli asintoti**: $xy = k$.
- *Funzione* **omografica**: $y = \dfrac{ax + b}{cx + d}$.

  Se $c \neq 0$ e $ad \neq bc$ essa è rappresentata, in coordinate cartesiane ortogonali, da un'iperbole equilatera che ha per asintoti le rette di equazioni:

$$x = -\frac{d}{c} \quad \text{e} \quad y = \frac{a}{c}.$$

Parabola

Parabola, *ad asse parallelo all'asse y, di fuoco F e direttrice d*:

$$y = ax^2 + by + c.$$

In una tale parabola:

- *il* **vertice** *è il punto di coordinate*: $\boxed{-\dfrac{b}{2a},\quad -\dfrac{\Delta}{4a}}$ (*con* : $\Delta = b^2 - 4ac$),

  *l'***asse di simmetria** *è la retta parallela all'asse y, di equazione*: $\boxed{x = -\dfrac{b}{2a}}$

- *il* **fuoco** *è il punto di coordinate*: $\boxed{-\dfrac{b}{2a},\ \dfrac{1}{4a} - \dfrac{\Delta}{4a}}$

  e la **direttrice** *è la retta parallela all'asse x, di equazione*: $\boxed{y = -\dfrac{1}{4a} - \dfrac{\Delta}{4a}}$

- *In particolare, se il vertice è nell'origine delle coordinate, la parabola ha equazione* $y = ax^2$ *e si ha*:

$$\textit{vertice}: \ V(0,\ 0); \qquad \textit{asse}: \ x = 0; \qquad F\left(0;\ \frac{1}{4a}\right); \qquad \textit{direttrice}: \ y = -\frac{1}{4a}.$$

  Analoghi risultati, se si assume l'asse y parallelo alla direttrice.

Trasformazione delle coordinate

- **Traslazione** *Se* $P(x,\ y)$ *nel sistema Oxy e* $P(X,\ Y)$ *nel sistema* $O'XY$, $O'(a,\ b)$ *nel sistema Oxy e gli assi sono rispettivamente* **paralleli** *ed* **equiversi**:

$$\begin{cases} x = X + a \\ y = Y + b \end{cases} \qquad \textit{oppure}: \qquad \begin{cases} X = x - a \\ Y = y - b. \end{cases}$$

- **Rotazione** *Se* $P(x,\ y)$ *nel sistema Oxy e* $P(X,\ Y)$ *nel sistema OXY e* $\alpha = xX$:

$$\begin{cases} x = X\cos\alpha - Y\,\mathrm{sen}\,\alpha \\ y = X\,\mathrm{sen}\,\alpha + Y\cos\alpha, \end{cases} \qquad \textit{oppure}: \qquad \begin{cases} X = x\cos\alpha + y\,\mathrm{sen}\,\alpha \\ Y = -x\cos\alpha + y\cos\alpha. \end{cases}$$

- **Rototraslazione** *Se* $P(x,\ y)$ *nel sistema Oxy,* $P(X,\ Y)$ *nel sistema* $O'XY$, $\alpha = xX$ *e* $O'(a,\ b)$ *nel sistema Oxy*:

$$\begin{cases} x = a + X\cos\alpha - Y\,\mathrm{sen}\,\alpha \\ y = b + X\,\mathrm{sen}\,\alpha + Y\cos\alpha, \end{cases} \qquad \textit{oppure}: \qquad \begin{cases} X = (x - a)\cos\alpha + (y - b)\,\mathrm{sen}\,\alpha \\ Y = -(x - a)\,\mathrm{sen}\,\alpha + (y - b)\cos\alpha. \end{cases}$$

- *Un punto P del piano, oltre che dalle coordinate cartesiane* x, y, *può essere individuato dalle* **coordinate polari**, *legate alle precedenti dalle relazioni*:

$$\begin{cases} x = \varrho\cos\vartheta \\ y = \varrho\,\mathrm{sen}\,\vartheta \end{cases} \qquad \textit{oppure}: \qquad \begin{cases} \varrho = \sqrt{x^2 + y^2} \\ \mathrm{tg}\,\vartheta = \dfrac{y}{x}. \end{cases}$$

ESPONENZIALI E LOGARITMI

- *Se* $a > 0,\ b > 0$ *e* $a \neq 1$, *l'equazione*: $a^x = b$ *ammette una e una sola soluzione*.
  $a^x = b \Leftrightarrow x = \log_a b \Rightarrow a^{\log_a b} = b$.
- **Teoremi sui logaritmi** (*salve le ipotesi su a, b, c, n, N*):

  1) $\log_a (bc) = \log_a b + \log_a c$;
  2) $\log_a b^c = c \log_a b$;
  3) $\log_a \dfrac{b}{c} = \log_a b - \log_a c$;
  4) $\log_a \sqrt[n]{b} = \dfrac{1}{n} \log_a b$;
  5) $\log_b N = \dfrac{\log_a N}{\log_a b}$;
  6) $\log_a b \cdot \log_b a = 1$;
  7) $\log_{a^n} b^m = \dfrac{m}{n} \log_a b$;
  8) $\log_a b = \log_{a^n} b^n$.

  Attenzione: $\log x^2 = 2 \log |x|$.

FORMULE DI TRIGONOMETRIA

Espressione di tutte le funzioni goniometriche di un angolo orientato mediante una sola di esse.

Noto	$\operatorname{sen}\alpha$	$\cos\alpha$	$\operatorname{tg}\alpha$	$\operatorname{ctg}\alpha$
$\operatorname{sen}\alpha$	$\operatorname{sen}\alpha$	$\sqrt{1-\operatorname{sen}^2\alpha}$	$\dfrac{\operatorname{sen}\alpha}{\pm\sqrt{1-\operatorname{sen}^2\alpha}}$	$\pm\dfrac{\sqrt{1-\operatorname{sen}^2\alpha}}{\operatorname{sen}\alpha}$
$\cos\alpha$	$\pm\sqrt{1-\cos^2\alpha}$	$\cos\alpha$	$\pm\dfrac{\sqrt{1-\cos^2\alpha}}{\cos\alpha}$	$\dfrac{\cos\alpha}{\pm\sqrt{1-\cos^2\alpha}}$
$\operatorname{tg}\alpha$	$\dfrac{\operatorname{tg}\alpha}{\pm\sqrt{1+\operatorname{tg}^2\alpha}}$	$\dfrac{1}{\pm\sqrt{1+\operatorname{tg}^2\alpha}}$	$\operatorname{tg}\alpha$	$\dfrac{1}{\operatorname{tg}\alpha}$
$\operatorname{ctg}\alpha$	$\dfrac{1}{\pm\sqrt{1+\operatorname{ctg}^2\alpha}}$	$\dfrac{\operatorname{ctg}\alpha}{\pm\sqrt{1+\operatorname{ctg}^2\alpha}}$	$\dfrac{1}{\operatorname{ctg}\alpha}$	$\operatorname{ctg}\alpha$

Angoli associati

ANGOLI OPPOSTI

$$\begin{cases} \operatorname{sen}(-\alpha) = -\operatorname{sen}\alpha \\ \cos(-\alpha) = \cos\alpha \\ \operatorname{tg}(-\alpha) = -\operatorname{tg}\alpha \end{cases}$$

ANGOLI SUPPLEMENTARI

$$\begin{cases} \operatorname{sen}(\pi-\alpha) = \operatorname{sen}\alpha \\ \cos(\pi-\alpha) = -\cos\alpha \\ \operatorname{tg}(\pi-\alpha) = -\operatorname{tg}\alpha \end{cases}$$

ANGOLI CHE DIFFERISCONO DI UN ANGOLO PIATTO

$$\begin{cases} \operatorname{sen}(\alpha+\pi) = -\operatorname{sen}\alpha \\ \cos(\alpha+\pi) = -\cos\alpha \\ \operatorname{tg}(\alpha+\pi) = \operatorname{tg}\alpha \end{cases}$$

ANGLI ESPLEMENTARI[(1)]

$$\begin{cases} \operatorname{sen}(2\pi-\alpha)=-\operatorname{sen}\alpha \\ \cos(2\pi-\alpha)=\cos\alpha \\ \operatorname{tg}(2\pi-\alpha)=-\operatorname{tg}\alpha \end{cases}$$

ANGOLI COMPLEMENTARI

$$\begin{cases} \operatorname{sen}\left(\frac{\pi}{2}-\alpha\right)=\cos\alpha \\ \cos\left(\frac{\pi}{2}-\alpha\right)=\operatorname{sen}\alpha \\ \operatorname{tg}\left(\frac{\pi}{2}-\alpha\right)=\operatorname{ctg}\alpha \end{cases}$$

ANGOLI CHE DIFFERISCONO DI UN ANGOLO RETTO

$$\begin{cases} \operatorname{sen}\left(\alpha+\frac{\pi}{2}\right)=\cos\alpha \\ \cos\left(\alpha+\frac{\pi}{2}\right)=-\operatorname{sen}\alpha \\ \operatorname{tg}\left(\alpha+\frac{\pi}{2}\right)=-\operatorname{ctg}\alpha \end{cases}$$

Formule goniometriche

FORMULE DI ADDIZIONE

$$\begin{cases} \operatorname{sen}(\alpha+\beta)=\operatorname{sen}\alpha\cos\beta+\operatorname{sen}\beta\cos\alpha \\ \cos(\alpha+\beta)=\cos\alpha\cos\beta-\operatorname{sen}\alpha\operatorname{sen}\beta \\ \operatorname{tg}(\alpha+\beta)=\dfrac{\operatorname{tg}\alpha+\operatorname{tg}\beta}{1-\operatorname{tg}\alpha\operatorname{tg}\beta}. \end{cases}$$

FORMULE DI SOTTRAZIONE

$$\begin{cases} \operatorname{sen}(\alpha-\beta)=\operatorname{sen}\alpha\cos\beta-\operatorname{sen}\beta\cos\alpha \\ \cos(\alpha-\beta)=\cos\alpha\cos\beta+\operatorname{sen}\alpha\operatorname{sen}\beta \\ \operatorname{tg}(\alpha-\beta)=\dfrac{\operatorname{tg}\alpha-\operatorname{tg}\beta}{1+\operatorname{tg}\alpha\operatorname{tg}\beta}. \end{cases}$$

FORMULE DI DUPLICAZIONE

$$\begin{cases} \operatorname{sen}2\alpha=2\operatorname{sen}\alpha\cos\alpha \\ \cos2\alpha=\cos^2\alpha-\operatorname{sen}^2\alpha=1-2\operatorname{sen}^2\alpha= \\ \qquad =2\cos^2\alpha-1 \\ \operatorname{tg}2\alpha=\dfrac{2\operatorname{tg}\alpha}{1-\operatorname{tg}^2\alpha}. \end{cases}$$

FORMULE DI TRIPLICAZIONE

$$\begin{cases} \operatorname{sen}3\alpha=3\operatorname{sen}\alpha-4\operatorname{sen}^3\alpha \\ \cos3\alpha=4\cos^3\alpha-3\cos\alpha \\ \operatorname{tg}\alpha=\dfrac{3\operatorname{tg}\alpha-\operatorname{tg}^3\alpha}{1-3\operatorname{tg}^2\alpha}. \end{cases}$$

FORMULE DI BISEZIONE

$$\begin{cases} \operatorname{sen}\dfrac{\alpha}{2}=\pm\sqrt{\dfrac{1-\cos\alpha}{2}}, \\ \cos\dfrac{\alpha}{2}=\pm\sqrt{\dfrac{1+\cos\alpha}{2}}, \\ \operatorname{tg}\dfrac{\alpha}{2}=\pm\sqrt{\dfrac{1-\cos\alpha}{1+\cos\alpha}}=\dfrac{\operatorname{sen}\alpha}{1+\cos\alpha}=\dfrac{1-\cos\alpha}{\operatorname{sen}\alpha.} \end{cases}$$

FORMULE DI PROSTAFERESI

$$\begin{cases} \operatorname{sen}p+\operatorname{sen}q=2\operatorname{sen}\dfrac{p+q}{2}\cos\dfrac{p-q}{2} \\ \operatorname{sen}p-\operatorname{sen}q=2\cos\dfrac{p+q}{2}\operatorname{sen}\dfrac{p-q}{2} \\ \cos p+\cos q=2\cos\dfrac{p+q}{2}\cos\dfrac{p-q}{2} \\ \cos p-\cos q=-2\operatorname{sen}\dfrac{p+q}{2}\operatorname{sen}\dfrac{p-q}{2}. \end{cases}$$

FORMULE DI WERNER

$$\begin{cases} \operatorname{sen}\alpha\operatorname{sen}\beta=\dfrac{1}{2}[\cos(\alpha-\beta)-\cos(\alpha+\beta)] \\ \cos\alpha\cos\beta=\dfrac{1}{2}[\cos(\alpha+\beta)+\cos(\alpha-\beta)] \\ \operatorname{sen}\alpha\cos\beta=\dfrac{1}{2}[\operatorname{sen}(\alpha+\beta)+\operatorname{sen}(\alpha-\beta)]. \end{cases}$$

ESPRESSIONE DI $\operatorname{sen}\alpha$ E $\cos\alpha$ IN FUNZIONE RAZIONALE DI $\operatorname{tg}\dfrac{\alpha}{2}$

$$\operatorname{sen}\alpha=\frac{2\operatorname{tg}\frac{\alpha}{2}}{1+\operatorname{tg}^2\frac{\alpha}{2}};\quad \cos\alpha=\frac{1-\operatorname{tg}^2\frac{\alpha}{2}}{1+\operatorname{tg}^2\frac{\alpha}{2}};\quad \text{cioè:}\quad \operatorname{sen}\alpha=\frac{2t}{1+t^2};\quad \cos\alpha=\frac{1-t^2}{1+t^2},\quad \text{con}\quad t=\operatorname{tg}\frac{\alpha}{2}.$$

(1) Si noti che le formule sono ancora quelle degli angoli *opposti*.

Funzioni goniometriche di angoli notevoli

Angolo orientato		Funzione goniometrica			
in gradi	in radianti	seno	coseno	tangente	cotangente
$0°$	0	0	1	0	*non esiste*
$9°$	$\frac{\pi}{20}$	$\frac{\sqrt{3+\sqrt{5}}-\sqrt{5-\sqrt{5}}}{4}$	$\frac{\sqrt{3+\sqrt{5}}+\sqrt{5-\sqrt{5}}}{4}$	$\frac{4-\sqrt{10+2\sqrt{5}}}{\sqrt{5}-1}$	$\frac{\sqrt{5}-1}{4-\sqrt{10+2\sqrt{5}}}$
$15°$	$\frac{\pi}{12}$	$\frac{\sqrt{6}-\sqrt{2}}{4}$	$\frac{\sqrt{6}+\sqrt{2}}{4}$	$2-\sqrt{3}$	$2+\sqrt{3}$
$18°$	$\frac{\pi}{10}$	$\frac{\sqrt{5}-1}{4}$	$\sqrt{\frac{10+2\sqrt{5}}{4}}$	$\sqrt{\frac{5-2\sqrt{5}}{5}}$	$\sqrt{5+2\sqrt{5}}$
$22°30'$	$\frac{\pi}{8}$	$\frac{\sqrt{2-\sqrt{2}}}{2}$	$\frac{\sqrt{2+\sqrt{2}}}{2}$	$\sqrt{2}-1$	$\sqrt{2}+1$
$30°$	$\frac{\pi}{6}$	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}=\frac{\sqrt{3}}{3}$	$\sqrt{3}$
$36°$	$\frac{\pi}{5}$	$\frac{\sqrt{10-2\sqrt{5}}}{4}$	$\frac{\sqrt{5}+1}{4}$	$\sqrt{5-2\sqrt{5}}$	$\frac{\sqrt{25+10\sqrt{5}}}{5}$
$45°$	$\frac{\pi}{4}$	$\frac{1}{\sqrt{2}}=\frac{\sqrt{2}}{2}$	$\frac{1}{\sqrt{2}}=\frac{\sqrt{2}}{2}$	1	1
$54°$	$\frac{3\pi}{10}$	$\frac{\sqrt{5}+1}{4}$	$\frac{\sqrt{10-2\sqrt{5}}}{4}$	$\frac{\sqrt{25+10\sqrt{5}}}{5}$	$\sqrt{5-2\sqrt{5}}$
$60°$	$\frac{\pi}{3}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$	$\frac{1}{\sqrt{3}}=\frac{\sqrt{3}}{3}$
$72°$	$\frac{3\pi}{5}$	$\frac{\sqrt{10+2\sqrt{5}}}{4}$	$\frac{\sqrt{5}-1}{4}$	$\sqrt{5+2\sqrt{5}}$	$\frac{\sqrt{25-10\sqrt{5}}}{5}$
$75°$	$\frac{5\pi}{12}$	$\frac{\sqrt{6}+\sqrt{2}}{4}$	$\frac{\sqrt{6}-\sqrt{2}}{4}$	$2+\sqrt{3}$	$2-\sqrt{3}$
$90°$	$\frac{\pi}{2}$	1	0	*non esiste*	0

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