

Equazioni goniometriche

elementari		
1	$\operatorname{sen} x = \frac{1}{2}$	$x = \frac{\pi}{6} + 2k\pi, x = \frac{5}{6}\pi + 2k\pi$
2	$\operatorname{cos} x = \frac{\sqrt{2}}{2}$	$x = \frac{\pi}{4} + 2k\pi, x = \frac{7}{4}\pi + 2k\pi$
3	$\operatorname{tg} x = 1$	$x = \frac{\pi}{4} + k\pi$
4	$\operatorname{cotg} x = -\sqrt{3}$	$x = \frac{5}{6}\pi + k\pi$

riconcucibili ad elementari		
5	$\operatorname{sen}\left(2x + \frac{\pi}{5}\right) = \frac{1}{2}$	$x = -\frac{\pi}{60} + k\pi, x = \frac{19}{60}\pi + k\pi$
6	$\operatorname{cos}\left(2x + \frac{\pi}{4}\right) = \frac{\sqrt{2}}{2}$	$x = k\pi, x = -\frac{\pi}{4} + k\pi$
7	$\operatorname{tg} 3x = 1$	$x = \frac{\pi}{12} + k\frac{\pi}{3}$
8	$\operatorname{cotg}\left(2x + \frac{\pi}{18}\right) = 0$	$x = \frac{2}{9}\pi + k\frac{\pi}{2}$
9	$\operatorname{sen}\left(x + \frac{\pi}{3}\right) = -1$	$x = \frac{7}{6}\pi + 2k\pi$
10	$\operatorname{cos}\frac{1}{2}x = -1$	$2\pi + 4k\pi$
11	$\operatorname{tg}\left(3x + \frac{\pi}{6}\right) = -1$	$x = \frac{7}{36}\pi + k\frac{\pi}{3}$
12	$\operatorname{cotg}\left(x + \frac{2}{3}\pi\right) = -\sqrt{3}$	$x = \frac{\pi}{6} + k\pi$
13	$\operatorname{sen}\left(2x - \frac{\pi}{3}\right) = \operatorname{sen}\left(\frac{\pi}{4} - 3x\right)$	$x = \frac{7}{60}\pi + k\frac{2\pi}{5}, x = -\frac{13}{12}\pi + 2k\pi$
14	$\operatorname{cos}\left(\frac{\pi}{2} + x\right) = \operatorname{cos} x$	$x = \frac{\pi}{4} + k\pi$
15	$\operatorname{tg}(2x - \pi) = \operatorname{tg}\frac{x}{2}$	$x = (k+1)\frac{2}{3}\pi$
16	$\operatorname{cotg}(2x - \pi) = \operatorname{cotg}\left(x + \frac{\pi}{3}\right)$	$x = \frac{4}{3}\pi + k\pi$
17	$\operatorname{sen}(2x - \pi) = \operatorname{cos} x$	$x = \frac{\pi}{2} + k\pi, x = -\frac{\pi}{6} + 2k\pi$ $x = \frac{7}{6}\pi + 2k\pi$
18	$\operatorname{cos} x = -\operatorname{sen} x$	$x = -\frac{\pi}{4} + k\pi$
19	$\operatorname{tg}\left(2x - \frac{\pi}{6}\right) = \operatorname{cotg}\left(\frac{\pi}{6} - x\right)$	$x = \frac{\pi}{2} + k\pi$

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20	$\cotg\left(\frac{\pi}{2} - 3x\right) = -\operatorname{tg}\left(x + \frac{\pi}{3}\right)$	$x = -\frac{\pi}{12} + k\frac{\pi}{4}$
di secondo grado		
21	$2\operatorname{sen}^2x + \operatorname{sen}x - 1 = 0$	$x = \frac{\pi}{6} + 2k\pi, x = \frac{5\pi}{6} + 2k\pi, x = \frac{3}{2}\pi + 2k\pi$
22	$2\cos^2x - 3\cos x + 1 = 0$	$x = \pm\frac{\pi}{3} + 2k\pi, x = 2k\pi$
23	$\operatorname{tg}^2x + (1 - \sqrt{3})\operatorname{tg}x - \sqrt{3} = 0$	$x = -\frac{\pi}{4} + k\pi, x = \frac{\pi}{3} + k\pi$
24	$\cotg^2x - 2\cotg x + 1 = 0$	$x = \frac{\pi}{4} + k\pi$
25	$\operatorname{sen}^2x - 1 = 0$	$x = \frac{\pi}{2} + k\pi$
26	$4\cos^2x - 3 = 0$	$x = \pm\frac{\pi}{6} + 2k\pi, x = \pm\frac{5\pi}{6} + 2k\pi$
27	$\operatorname{tg}^2x - 1 = 0$	$x = \frac{\pi}{4} + k\frac{\pi}{2}$
28	$3\cotg^2x - 1 = 0$	$x = \pm\frac{\pi}{3} + k\pi$
29	$2\operatorname{sen}^2x - \sqrt{2}\operatorname{sen}x = 0$	$x = \frac{\pi}{4} + 2k\pi, x = \frac{3}{4}\pi + 2k\pi, x = k\pi$
30	$\cos^2x - \frac{\sqrt{2}}{2}\cos x = 0$	$x = \frac{\pi}{4} + k\pi, x = \frac{\pi}{2} + k\pi$
31	$\operatorname{tg}^2x + \operatorname{tg}x = 0$	$x = k\pi, x = -\frac{\pi}{4} + k\pi$
32	$\cotg^2x + \cotg x = 0$	$x = \frac{\pi}{2} + k\pi, x = -\frac{\pi}{4} + k\pi$
lineari in seno e coseno		
33	$\sqrt{3}\operatorname{sen}x + \cos x + 1 = 0$	$x = \pi + 2k\pi, x = -\frac{\pi}{3} + 2k\pi$
34	$\operatorname{sen}x - \cos x - 1 = 0$	$x = \pi + 2k\pi, x = \frac{\pi}{2} + 2k\pi$
35	$3\operatorname{sen}x + \sqrt{3}\cos x + \sqrt{3} = 0$	$x = \pi + 2k\pi, x = -\frac{\pi}{3} + 2k\pi$
36	$2\cos x + 2\operatorname{sen}x - (\sqrt{3} + 1) = 0$	$x = \frac{\pi}{3} + 2k\pi, x = \frac{\pi}{6} + 2k\pi$
37	$3\operatorname{sen}x - \sqrt{3}\cos x = 0$	$x = \frac{\pi}{6} + k\pi$

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38	$\operatorname{sen} x + \sqrt{3} \operatorname{cos} x = 0$	$x = -\frac{\pi}{3} + k\pi$
39	$\operatorname{sen} x - (2 + \sqrt{3}) \operatorname{cos} x = 0$	$x = \frac{5}{12}\pi + k\pi$
40	$\sqrt{3} \operatorname{sen} x + 3 \operatorname{cos} x = 0$	$x = -\frac{\pi}{3} + k\pi$

omogenee in seno e coseno

41	$6 \operatorname{sen}^2 x - 8 \operatorname{sen} x \operatorname{cos} x + 4 \operatorname{cos}^2 x - 1 = 0$	$x = \frac{\pi}{4} + k\pi, x = \operatorname{arctg} \frac{3}{5} + k\pi$
42	$2 \operatorname{sen}^2 x + \sqrt{3} \operatorname{sen} x \operatorname{cos} x - \operatorname{cos}^2 x - 2 = 0$	$x = \pm \frac{\pi}{2} + 2k\pi, x = \frac{\pi}{3} + k\pi$
43	$\sqrt{3} \operatorname{cos}^2 x + \operatorname{sen} x \operatorname{cos} x = 0$	$x = \pm \frac{\pi}{2} + 2k\pi, x = -\frac{\pi}{3} + k\pi$
44	$3 \operatorname{cos}^2 x + \sqrt{3} \operatorname{sen} x \operatorname{cos} x = 0$	$x = \frac{\pi}{2} + k\pi, x = \frac{2}{3}\pi + k\pi$
45	$\operatorname{sen}^2 x - 3 \operatorname{cos}^2 x = 0$	$x = \pm \frac{\pi}{3} + k\pi$
46	$4 \operatorname{sen}^2 x - 9 \operatorname{cos}^2 x = 0$	$x = \pm \operatorname{arctg} \frac{3}{2} + k\pi$
47	$\sqrt{3} \operatorname{sen}^2 x - \operatorname{sen} x \operatorname{cos} x = 0$	$x = k\pi, x = \frac{\pi}{6} + k\pi$
48	$\operatorname{sen}^2 x + (\sqrt{3} - 2) \operatorname{sen} x \operatorname{cos} x = 0$	$x = k\pi, x = \frac{\pi}{12} + k\pi$
49	$2 \operatorname{sen} x \operatorname{cos} x - 1 = 0$	$x = \frac{\pi}{4} + k\pi$
50	$4 \operatorname{sen} x \operatorname{cos} x - 1 = 0$	$x = \frac{\pi}{12} + k\pi, x = \frac{5\pi}{12} + k\pi$
51	$\sqrt{3} \operatorname{sen}^2 x - 2 \operatorname{sen} x \operatorname{cos} x - \sqrt{3} \operatorname{cos}^2 x = 0$	$x = -\frac{\pi}{6} + k\pi, x = \frac{\pi}{3} + k\pi$
52	$3 \operatorname{sen}^2 x - 8\sqrt{3} \operatorname{sen} x \operatorname{cos} x + 15 \operatorname{cos}^2 x = 0$	$x = \frac{\pi}{3} + k\pi, x = \operatorname{arctg} \frac{5\sqrt{3}}{3}$
53	$3 \operatorname{sen}^4 x - 4 \operatorname{sen}^2 x \operatorname{cos}^2 x + \operatorname{cos}^4 x = 0$	$x = \pm \frac{\pi}{4} + k\pi, x = \pm \frac{\pi}{6} + k\pi$
54	$4 \operatorname{sen}^2 x \operatorname{cos}^2 x - 4 \operatorname{cos}^4 x = 0$	$x = \frac{\pi}{2} + k\pi, x = \frac{\pi}{4} + k\frac{\pi}{2}$

simmetriche

55	$\operatorname{sen} x + \operatorname{cos} x + 2 \operatorname{sen} x \operatorname{cos} x + 1 = 0$	$x = -\frac{\pi}{2} + 2k\pi, x = -\frac{\pi}{4} + k\pi$
56	$\operatorname{sen} x + \operatorname{cos} x + 2 \operatorname{sen} x \operatorname{cos} x - (1 + \sqrt{2}) = 0$	$x = \frac{\pi}{4} + 2k\pi$

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57	$\operatorname{sen} x + \operatorname{cos} x = 1$	$x = 2k\pi, x = \frac{\pi}{2} + 2k\pi$
58	$\operatorname{sen}^3 x + \operatorname{cos}^3 x = 0$	$x = -\frac{\pi}{4} + k\pi$

di riepilogo prima parte

59	$2\operatorname{cos} x - 5 = 0$	<i>impossibile</i>
60	$\operatorname{sen}^2 x + (1 - \sqrt{3})\operatorname{sen} x \operatorname{cos} x - \sqrt{3}\operatorname{cos}^2 x = 0$	$x = -\frac{\pi}{4} + k\pi, x = \frac{\pi}{3} + k\pi$
61	$3\operatorname{sen}^2 x + 7\operatorname{sen} x = 0$	$x = k\pi$
62	$\operatorname{cos} x = -\operatorname{cos} 2x$	$x = \frac{\pi}{3} + \frac{2}{3}k\pi$
63	$\sqrt{3}\operatorname{sen} x + \operatorname{cos} x = 1$	$x = 2k\pi, x = \frac{2}{3}\pi + 2k\pi$
64	$\sqrt{3}\operatorname{sen} x \operatorname{cos} x - \operatorname{cos}^2 x = 0$	$x = \frac{\pi}{2} + k\pi, x = \frac{\pi}{6} + k\pi$
65	$\operatorname{cos} x + \sqrt{3}\operatorname{sen} x = -1$	$x = \pi + 2k\pi, x = -\frac{\pi}{3} + 2k\pi$
66	$5\operatorname{sen}^2 x - 3\operatorname{sen} x \operatorname{cos} x - 2\operatorname{cos}^2 x = 0$	$x = \frac{\pi}{4} + k\pi, x = -\operatorname{arctg} \frac{2}{5} + k\pi$
67	$3\operatorname{tg}^2 x + 2\sqrt{3}\operatorname{tg} x - 3 = 0$	$x = -\frac{\pi}{3} + k\pi, x = \frac{\pi}{6} + k\pi$
68	$\operatorname{sen} x - \sqrt{3}\operatorname{cos} x = 0$	$x = \frac{\pi}{3} + k\pi$

riducibili ad una sola funzione goniometrica

69	$\operatorname{sen} x (\operatorname{tg} x - \sqrt{3}) = 0$	$x = k\pi, x = \frac{\pi}{3} + k\pi$
70	$3\operatorname{cos}^2 x + 2\operatorname{sen}^2 x - \operatorname{tg}^2 x = \frac{3}{2}$	$\pm \frac{\pi}{4} + k\pi$
71	$\operatorname{tg}^2 x + 3\operatorname{cotg}^2 x - 4 = 0$	$x = \pm \frac{\pi}{3} + k\pi, x = \pm \frac{\pi}{4} + k\pi$
72	$\sqrt{2}\operatorname{cosec} x + 2 = \operatorname{cotg} x (\sqrt{2} + 2\operatorname{sen} x)$	$x = -\frac{\pi}{4} + 2k\pi, x = \frac{5}{4}\pi + 2k\pi$

risolubili mediante formule di addizione e sottrazione

73	$\operatorname{cos} \left(\frac{\pi}{6} + x \right) + \operatorname{cos} \left(\frac{\pi}{6} - x \right) - \frac{3}{2} = 0$	$x = \pm \frac{\pi}{6} + 2k\pi$
74	$2\operatorname{sen} \left(x - \frac{\pi}{4} \right) + 2\operatorname{sen} \left(x + \frac{\pi}{4} \right) = \sqrt{2}$	$x = \frac{\pi}{6} + 2k\pi, x = \frac{5}{6}\pi + 2k\pi$

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75	$tg\left(\frac{\pi}{6} + x\right) + tg\left(\frac{\pi}{3} - x\right) = 2$	$x = \frac{\pi}{12} + k\pi$
76	$tg\left(\frac{\pi}{4} - x\right) \cotg\left(\frac{\pi}{4} + x\right) = 7 - 4\sqrt{3}$	$x = \frac{\pi}{6} + k\pi, x = \frac{\pi}{3} + k\pi$

risolubili mediante formule di duplicazione

77	$2\text{sen}2x - \text{tg}x = 0$	$x = k\pi, x = \pm\frac{\pi}{3} + 2k\pi, x = \pm\frac{2}{3}\pi + 2k\pi$
78	$\text{sen}2x - \text{sen}x = 0$	$x = k\pi, x = \pm\frac{\pi}{3} + 2k\pi$
79	$\sqrt{3}\cos x - \cos 2x - 1 = 0$	$x = \frac{\pi}{2} + k\pi, x = \pm\frac{\pi}{6} + 2k\pi$
80	$\cotg x - \text{sen}2x = 0$	$x = \frac{\pi}{2} + k\pi, x = \frac{\pi}{4} + k\frac{\pi}{2}$

risolubili mediante formule di bisezione

81	$tg^2\frac{x}{2} + 2\cos x - \frac{4}{3} = 0$	$x = \pm\frac{\pi}{3} + 2k\pi, x = \pm\arccos\left(-\frac{1}{3}\right) + 2k\pi$
82	$\cos^2\frac{x}{2} - \text{sen}^2\frac{x}{2} - \sqrt{2}\cos^2x = 0$	$x = \frac{\pi}{2} + k\pi, x = \frac{\pi}{4} + k\pi$
83	$tg^2\frac{x}{2} = 4\text{sen}^2\frac{x}{2}$	$x = 2k\pi, x = \pm\frac{\pi}{3} + 2k\pi$
84	$\frac{1 - \cos x}{1 + \cos x} = 4\text{sen}^2\frac{x}{2}$	$x = 2k\pi, x = \pm\frac{2}{3}\pi + 2k\pi$

risolubili mediante formule di prostaferesi e Werner

84	$\text{sen}6x - \text{sen}4x = 2\text{sen}x$	$x = k\pi, x = k\frac{2}{5}\pi$
86	$\text{sen}3x + \text{sen}x = \cos x$	$x = \frac{\pi}{2} + k\pi, x = \frac{\pi}{12} + k\pi, x = \frac{5\pi}{12} + k\pi$
87	$\text{sen}x \cos 3x = \text{sen}2x \cos 4x$	$x = k\pi, x = \frac{\pi}{10} + k\frac{\pi}{5}$
88	$\text{sen}x \text{sen}2x = \text{sen}3x \text{sen}4x$	$x = k\frac{\pi}{2}, x = k\frac{\pi}{5}$

di riepilogo

89	$\text{sen}^2x + \cos 2x = 1$	$x = k\pi$
90	$\text{sen}3x = \text{sen}\left(\frac{2\pi}{3} + x\right)$	$x = \frac{\pi}{3} + k\pi, x = \frac{\pi}{12} + \frac{\pi}{2}k$
91	$\text{sen}\left(x + \frac{\pi}{6}\right) - 2\cos x = 0$	$x = \frac{\pi}{3} + k\pi$

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92	$\text{sen}3x + \text{sen}x = 0$	$x = k\frac{\pi}{2}$
93	$\text{tg}\left(x - \frac{\pi}{3}\right) = \text{cotg}\left(x + \frac{\pi}{3}\right)$	$x = \frac{\pi}{4} + k\frac{\pi}{2}$
94	$\text{cos}x - 2\text{sen}x \text{cos}x - \text{sen}x + 2\text{sen}^2x = 0$	$x = \frac{\pi}{6} + 2k\pi, x = -\frac{\pi}{6} + 2k\pi, x = \pm\frac{\pi}{4} + 2k\pi$
95	$\text{sen}^4x - \text{sen}^2x \text{cos}^2x - \text{sen}^2x + \text{cos}^2x = 0$	$x = \pm\frac{\pi}{4} + 2k\pi, x = \frac{\pi}{2} + k\pi$
96	$4\text{sen}^2x + \text{cos}^2x - 7 = 0$	$x = \pm\frac{\pi}{3} + 2k\pi, x = \pm\frac{2}{3}\pi + 2k\pi$
97	$2\text{sen}^2\frac{x}{2} - \text{sen}2x + \text{cos}x = 0$	$x = \frac{\pi}{4} + k\pi$
98	$\text{sen}x - \text{cos}x + 1 = 2\text{sen}x \text{cos}x$	$x = 2k\pi, x = \frac{\pi}{4} + k\pi, x = -\frac{\pi}{2} + 2k\pi$
99	$\text{tg}2x - 3\text{tg}x = 0$	$x = k\pi, x = \pm\frac{\pi}{6} + k\pi$
100	$\text{sen}x - \text{tg}\frac{x}{2} - \text{cos}x = 0$	$x = \pm\frac{\pi}{2} + 2k\pi$
101	$\text{tg}2x - 2\sqrt{3}\text{cos}2x = 0$	$x = \frac{\pi}{6} + k\pi$
102	$2\text{sen}x + \text{tg}x - 1 = 2\text{cos}x$	$x = \pm\frac{2}{3}\pi + 2k\pi, x = \frac{\pi}{4} + k\pi$
103	$2\text{sen}\left(\frac{\pi}{3} + x\right) - \sqrt{3}\text{cos}x + 1 = 0$	$x = \frac{3}{2}\pi + 2k\pi$
104	$\text{sen}2x = 2\text{cos}x$	$x = \frac{\pi}{2} + k\pi$
105	$\text{cos}8x + \text{cos}4x = 2\text{cos}6x$	$x = k\pi, x = \frac{\pi}{12} + k\frac{\pi}{6}$
106	$\text{sen}\left(x + \frac{\pi}{6}\right) - \text{sen}\left(x - \frac{\pi}{6}\right) = \sqrt{3}\text{sen}\frac{\pi}{6}$	$x = \pm\frac{\pi}{6} + 2k\pi$
107	$\text{cos}\left(\frac{\pi}{4} - x\right) + \text{cos}\left(\frac{\pi}{4} + x\right) - \frac{\sqrt{6}}{4} = 0$	$x = \pm\frac{\pi}{6} + 2k\pi$
108	$3\text{sen}x \text{cos}x - \sqrt{3}\text{cos}^2x - 3\text{sen}x + \sqrt{3}\text{cos}x = 0$	$x = 2k\pi, x = \frac{\pi}{6} + k\pi$
109	$\text{tg}3x - \text{tg}x = \text{sec}x \cdot \text{sen}2x$	$x = (2k + 1)\pi, x = \pm\frac{2}{3}\pi + k\pi$
110	$\text{tg}2x = \text{tg}(x + \alpha) + \text{tg}(x - \alpha)$	$x = k\frac{\pi}{2}, x = \pm\alpha + k\pi$
111	$2\text{sen}^2x + 3\text{sen}x - 1 = 0$	$x = \pi - \arcsen\left(\frac{-3 + \sqrt{17}}{4}\right) + 2k\pi \cup$ $x = \arcsen\left(\frac{-3 + \sqrt{17}}{4}\right) + 2k\pi$

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112	$4 \cos^2 x + 5 \cos x - 2 = 0$	$x = \pm \arccos \left(\frac{-5 + \sqrt{57}}{8} \right) + 2k\pi$
113	$-2 \cos^2 x + 4 \sin x \cos x + 3 \sin^2 x = 0$	$x = \operatorname{arctg} \left(\frac{-2 - \sqrt{10}}{3} \right) + k\pi \cup$ $x = \operatorname{arctg} \left(\frac{-2 + \sqrt{10}}{3} \right) + k\pi$
114	$\sqrt{3} \sin x + 5 \cos x + 1 = 0$	$x = -2 \operatorname{arctg} \left(\frac{\sqrt{3}}{2} \right) + 2k\pi \cup$ $x = \frac{2}{3}\pi + 2k\pi$
115	$3 \operatorname{tg}^2 x - 4 \operatorname{tg} x + 3 = 0$	<i>impossibile</i>
116	$5 \sin^2 x + \sqrt{3} \sin x \cos x - 2 = 0$	$x = \operatorname{arctg} \left(-\frac{2\sqrt{3}}{3} \right) + k\pi \cup$ $x = \frac{1}{6}\pi + k\pi$
117	$\sqrt{2} \sin 2x + \sin^2 x + 1 = 0$	$x = -\frac{1}{8}\pi + k\pi \cup x = \frac{5}{8}\pi + k\pi$
118	$2 \sin 2x + \sqrt{5} \sin x = 0$	$x = k\pi \cup x = \pm \arccos \left(-\frac{\sqrt{5}}{4} \right) + 2k\pi$
119	$7 \cos^2 x + 5 \sin x + 4 = 0$	$x = \pi - \operatorname{arcsen} \left(\frac{5 - 3\sqrt{37}}{14} \right) + 2k\pi \cup$ $x = \left(\frac{5 - 3\sqrt{37}}{14} \right) + 2k\pi$
120	$\sin x + \sqrt{5} \cos x - 3 = 0$	<i>impossibile</i>