Universidad de las Fuerzas Armadas ESPE-L

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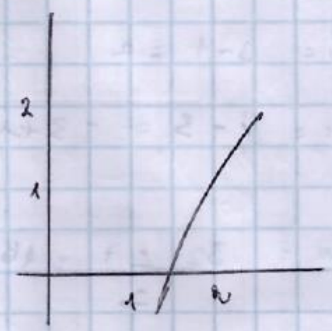
- En los siguientes ejercicios realizar 5 iteraciones con los metodos de la biseccion Regla falsa, Newton Raphson, la secante y Muller, tabular los resultados en cada caso y realizar una comparativa del comportamiento de error

1. Determine la raiz real de $\ln(x^2) = 0{,}7$

Metodo Biseccion

Iteracion	X_i	X_s	X_r	Error
1	1	2	1,5	100%
2	1	1,5	1,25	20%
3	1,25	1,5	1,375	9.09%
4	1,375	1,5	1,4375	4.35%
5	1,375	1,4375	1,40625	2.22%
6	1,40625	1,4375	1,421875	1,09%
7	1,40625	1,421875	1,414062	0,55%
8	1,414062	1,421875	1,417969	0,27%



Intervalo [1,2]

$f(1) = \ln(1) - 0{,}7 = -0{,}7$

$f(2) = \ln(2^2) - 0{,}7 = 0{,}682994$

1t = 1

$$x_r = \frac{X_i + X_s}{2} = \frac{1+2}{2} = \frac{3}{2} = 1{,}5$$

$$e = \left| \frac{1{,}5 - 0}{1{,}5} \right| x100 = 100\%$$

$f(1{,}5) = \ln(1{,}5^2) - 0{,}7 = 0{,}1109302$

$-$ $+$ $+$
x_i x_r x_s

it = 2

$$x_r = \frac{1{,}25 + 1{,}5}{1{,}25} = 1{,}25$$

$$e = \left| \frac{1{,}25 - 1{,}5}{1{,}25} \right| \cdot 100 = 20\%$$

$f(1{,}25) = \ln(1{,}25^2) - 0{,}7 = -0{,}2537213$

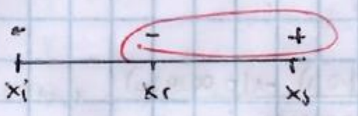
$-$ $-$ $+$
x_i x_r x_s

it=3

$x_r = \frac{1,25 + 1,5}{2} = 1,375$

$e = \left| \frac{1,375 - 1,25}{1,375} \right| \cdot 100 = 9,09\%$

$f(1,375) = \ln(1,375^5) - 0,7 = -0,06309$

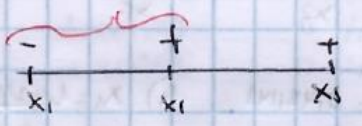


it=4

$x_r = \frac{1,375 + 1,5}{2} = 1,4375$

$e = \left| \frac{1,4375 - 1,375}{1,4375} \right| \cdot 100 = 4,35$

$f(1,375) = \ln(1,375^5) - 0,7 = \overset{+}{0},026$



it=5

$x_r = \left| \frac{1,375 + 1,4375}{2} \right| = 1,40625$

$e = \left| \frac{1,40625 - 1,4375}{1,40625} \right| \cdot 100 = 2,17\%$

$f(1,4375) = \ln(1,4375^5) - 0,7 = -0,018$

it=6

$x_r = \frac{1,40625 + 1,4375}{2} = 1,421875$

$e = \left| \frac{1,421875 - 1,40625}{1,421875} \right| \cdot 100 = 1,09$

$f(1,421875) = 0,0034528$

it=7

$x_r = \frac{1,40625 + 1,421875}{2} = 1,414062$

$e = \left| \frac{1,414062 - 1,421875}{1,414062} \right| \cdot 100 = 0,55\%$

$f(1,414062) = -0,007066$

$x_r = \frac{1,414062 + 1,421875}{2} = 1,4179$

$e = \left| \frac{1,417464 - 1,414062}{1,417464} \right| \cdot 100 = 0,27$

$f(1,4174) = 0,001549$

2 Regla Falsa

Iteración	x_i	x_s	x_r	Error %
1	1	2	1,504943	100%
2	1	1,504943	1,432312	5,07%
3	1	1,432362	1,421142	0,79%
4	1	1,421142	1,41927	0,12%
5	1	1,419392	1,419118	0,019%
6	1	1,419118	1,419074	0,003%
7	1	1,419071	1,419064	0,0004%
8	1	1,419064	1,41906	0,000073%

Intervalo [1,2] $f(x) = -0,7$ $f(2) = 0,686244$

1) $x_r = \dfrac{x_s\,f(x_i) - x_i\,f(x_s)}{f(x_i) - f(x_s)}$

$x_r = \left| \dfrac{1{,}504443 - 0}{1{,}504443} \right| \times 100 = 100\%$

$f(x_i) = 0{,}117540$

- + +
x_i x_r x_s

2) $x_r = \dfrac{1{,}504443(-0{,}7) - (1)(0{,}1)(0{,}117512)}{(-0{,}17) - (0{,}117512)} = 1{,}432362$

$e = \left| \dfrac{1{,}432362 - 1{,}504443}{1{,}432362} \right| \cdot 100 = 5.06\%$

$f(x_r) = 0{,}01865$

- + +
x_i x_r x_s

3) $x_r = \dfrac{1{,}432362(-0{,}17) - 1\,(0{,}01860)}{-0{,}7 - 0{,}01860} = 1{,}421141$

$e = \left| \dfrac{1{,}421141 - 1{,}432362}{1{,}421141} \right| \cdot 100 = 0{,}78\%$

$f(x_i) = 0{,}002920$

- + +
x_i x_r x_s

4) $x_r = \dfrac{1{,}421141(-0{,}7) - 1(0{,}002920)}{-0{,}7 - 0{,}002920} = 1{,}419342$

$e = \left| \dfrac{1{,}419342 - 1{,}421141}{1{,}419342} \right| \cdot 100 = 0{,}12\%$

$f(x_i) = 0{,}000457$

- + +
x_i x_r x_s

5) $x_r = \dfrac{1{,}41932(-0{,}17) - 1\,(0{,}00457)}{-0{,}7 - 0{,}000457} = 1{,}419118$

$e = \left| \dfrac{1{,}419118 - 1{,}41932}{1{,}419118} \right| \cdot 100 = 0{,}014\%$

$f(x_i) = 0.0000711$

6) $x_r = \dfrac{1{,}419181(-0{,}7)(-1)(7{,}135191)}{-0{,}7 - 7{,}135191} = 1{,}419007$

$e = \left| \dfrac{1{,}419074 - 1{,}419118}{1{,}419074} \right| \cdot 100 = 0{,}003\%$

7) $x_r = \dfrac{1{,}419075(0{,}7) - (1)(1{,}114890)}{-0{,}7 - 1{,}114869} = 1{,}419068$

$e = \dfrac{1{,}419068 - 1{,}419075}{1{,}419068} = 0{,}0004\%$

8) $x_r = \dfrac{1{,}419068(-0{,}7) - 1(1{,}749040)}{-0{,}7 - 1{,}749048} = 1{,}419067$

$e = \dfrac{1{,}419067 - 1{,}419067}{1{,}419067} = 0{,}000073\%$

Método Newton-Raphson

Iteración	x_i	x_{i+1}	Error
1	2	1,313706	52,24 %
2	1,313706	1,415056	7,16 %
3	1,415056	1,419062	0,282 %
4	1,419062	1,419068	0.0004 %
5	1,419068	1,4190675	0,0000355 %
6	1,419068	1,419069	0 %
7	1,419068	1,419068	0 %
8	1,419068	1,419068	0 %

$f(x) = \ln(x^2) - 0{,}7$

$f'(x) = \frac{2x}{x^2} = \frac{2}{x}$

Punto = $x_0 = 2$

1) $x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}$ $\quad x_2 = 2 - \frac{\ln(2)^2 - 0{,}7}{2/2} = 1{,}313706$ $\quad e = \left| \frac{1{,}313706 - 2}{1{,}313706} \right| \cdot 100 = 52{,}24\%$

2) $x_3 = 1{,}313706 - \frac{\ln(1{,}313706^2) - 0{,}7}{2/1{,}313706} = 1{,}415056$ $\quad e = \left| \frac{1{,}415056 - 1{,}313706}{1{,}415056} \right| \cdot 100 = 7.16\%$

3) $x_4 = 1{,}415056 - \frac{\ln(1{,}415056^2) - 0{,}7}{2/1{,}415056} = 1{,}419062$ $\quad e = \left| \frac{1{,}419062 - 1{,}415056}{1{,}419062} \right| \cdot 100 = 0{,}282\%$

4) $x_5 = 1{,}419062 - \frac{\ln(1{,}419062^2) - 0{,}7}{2/1{,}419062)} = 1{,}419068$ $\quad e = \left| \frac{1{,}419068 - 1{,}419062}{1{,}419068} \right| \cdot 100 = 0{,}0004\%$

5) $x_6 = 1{,}41968 - \frac{\ln(1{,}419068) - 0{,}7}{2/1{,}419068} = 1{,}4190675$ $\quad e = \left| \frac{1{,}4190671 - 1{,}419068}{1{,}4190671} \right| \cdot 100 = 0{,}0035\%$

6) $x_7 = 1{,}41968 - \frac{\ln(1{,}419068) - 1{,}7}{2/1{,}41968} = 1{,}419068$ $\quad e = \left| \frac{1{,}41968 - 1{,}41968}{1{,}41968} \right| \cdot 100 = 0\%$

7) $x_8 = 1{,}41968 - \frac{\ln(1{,}41968) - 1{,}7}{2/1{,}419068} = 1{,}41968$ $\quad e = \left| \frac{1{,}41968 - 1{,}41968}{1{,}41968} \right| \cdot 100 = 0\%$

8) $x_9 = 1{,}41968 - \frac{\ln(1{,}419{,}68) - 1{,}7}{2/1{,}41968)} = 1{,}41968$ $\quad e = \left| \frac{1{,}41968 - 1{,}41968}{1{,}41968} \right| \cdot 100 = 0\%$

- Método de la Secante

Intervalo [1,2]

Iteración	x_i	x_{i-1}	x_{i+1}	Error
1	2	1	1,504443	32.40 %
2	1,504443	2	1,402603	7.24 %
3	1,402603	1,504443	1,419560	1,19 %
4	1,419560	1,402603	1,419070	0,035 %
5	1,419070	1,419560	1,4190675	0.00018 %
6	1,419068	1,419070	1,419068	$3{,}48 \times 10^{-8}$
7	1,41968	1,41968	1,4196800	$4{,}64 \times 10^{-11}$

8	1,419068	1,419068	1,41968	0%

1) $x_{i+1} = \frac{x_i f(x_{i-1}) - x_{i-1} f(x_i)}{f(x_{i-1}) - f(x_i)} = \frac{2(\ln(1) - 0{,}7) - 1(\ln(0{,}4^2) - 0{,}7)}{\ln(1) - 0{,}7 - (\ln(4) - 0{,}7)} = 1{,}504443$

$e = \left| \frac{1{,}504443 - 2}{1{,}504443} \right| \cdot 100 = 32{,}90\%$

2) $X_3 = \frac{1{,}504443(\ln(2^2) - 0{,}17) - 2(\ln(1{,}504443^2) - 0{,}7)}{\ln(2^2) - 0{,}17 - (\ln(1{,}504443^2) - 0{,}7)} = 1{,}402665$

$e = \left| \frac{1{,}402665 - 1{,}504443}{1{,}402665} \right| \cdot 100 = 7{,}29\%$

3) $X_4 = \frac{1{,}402665(\ln(1{,}504443^2) - 0{,}7) - 1{,}504444(\ln(1{,}402665^2) - 0{,}7)}{\ln(1{,}504443^2) - 0{,}7 - (\ln(1{,}402665^2) - 0{,}7)} = 1{,}419560$

$e = \left| \frac{1{,}419560 - 1{,}402665}{1{,}419560} \right| \cdot 100 = 1{,}19\%$

4) $X_5 = \frac{1{,}419560(\ln(1{,}40266) - 0{,}7) - 1{,}402665(\ln(1{,}419560^2) - 0{,}7)}{\ln(1{,}4026654) - 0{,}7 - (\ln(1{,}419560^2) - 0{,}17)}$

$e = \left| \frac{1{,}419070 - 1{,}419560}{1{,}419070} \right| \cdot 100 = 0{,}035\%$

5) $X_6 = \frac{1{,}419070(\ln(419560^2) - 0{,}7) - 1{,}419560(\ln(1{,}419070^2) - 0{,}7)}{\ln(1{,}419560^2) - 0{,}7 - \ln(1{,}419070^2) - 0{,}17} = 1{,}4190675$

$e = \left| \frac{1{,}4190675 - 1{,}419070}{1{,}4190675} \right| \cdot 100 = 0{,}00018\%$

6) $X_7 = \frac{1{,}419067(4{,}01838)\times10^{-6} - 1{,}419070 - (6{,}971425)}{4{,}018380\times10^{-6} - (-6{,}971425\times10^{-10})} = 1{,}419067$

$e = \frac{-6{,}661338\times10^{-14} - 4{,}694165}{-6{,}661338\times10^{-14}} = 0\%$

7 $x_i = \frac{1{,}419067(-6{,}971425\times10^{-10}) - 1{,}419067(7{,}771561\times10^{-16})}{-6{,}971425\times10^{-10} - 7{,}7715612\,e^{-16}} = 1{,}419067$

$e = \frac{-6{,}661338\times10^{-16} - 4{,}694\times10^{-14}}{-6{,}661338\times10^{-16}} = 0\%$

8) $xr = \frac{1,419067\,(7.771561 \times 10^{-16}) - 1,419067\,(-1,110223 \times 10^{-16})}{7.771561 \times 10^{-16} - (-1,1102230 \times 10^{-16})} = 1,419067$

$e = \left| \frac{1,41967 - 1,419067}{1,41967} \right| \times 100 = 0\%$

Miller

iteración	x_0	x_1	x_2	x_3	Error %
1	1	1,5	2	1,422084	40,64 %
2	1.5	2	1,422084	1,419030	0,2142 %
3	2	1,422084	1,419050	1,419068	0,00127 %
4	1,422084	1,419030	1,419068	1,419068	0%
5					
6					
7					
8					

1) $h_0 = x_1 - x_0 = 1,5 - 1 = 0,5$ $\quad f(x_0) = \ln(1)^2 - 0,7 = -0,7$

$h_1 = x_2 - x_1 = 2 - 1,5 = 0,5$ $\quad f(x_1) = \ln(1,5)^2 - 0,7 = 0,110930$

$f(x_2) = \ln(2)^2 - 0,7 = 0,686294$

$d_0 = \frac{f(x_1) - f(x_0)}{h_0} = \frac{0,110930 + 0,7}{0,5} = 1,62186$

$d_1 = \frac{f(x_2) - f(x_1)}{h_1} = \frac{0,686294 - 0,110930}{0,5} = 1,150728$

$a = \frac{d_1 - d_0}{h_1 + h_0} = \frac{1,150728 - 1,62186}{0,5 + 0,5} = -0,471117$

$b = a h_1 + d_1 = (-0,471132)(0,5) + 1,150728 = 0,915162$

$C = 0,686294$

$x_3 = x_2 - \frac{2c}{b^2 (\text{signo}) \sqrt{b^2 - 4ac}} = 2 - \frac{2(0,686294)}{0,915162 + \sqrt{0,915162^2 - 4(0,471132)(0,686294)}}$

$x_3 = 1,422089$

$x_0 = 1,5$

$x_1 = 2$

$x_3 = 1,422089$

$e = \left| \frac{x_3 - x_2}{x_3} \right| = \left| \frac{1,422089 - 2}{1,422089} \right| \times 100 = 40,64\%$

2) $h_0 = 2 - 1{,}5 = 0{,}5$ $\quad f(x_0) = 0{,}110430$

$h_1 = 1{,}422084 - 2 = -0{,}577911$ $\quad f(x_1) = 0{,}686294$

$f(x_2) = \ln(1{,}422084^2) - 0{,}7 = 0{,}004254$

$d_0 = \dfrac{0{,}686294 - 0{,}110430}{0{,}5} = 1{,}150728$

$a = \dfrac{1{,}180182 - 1{,}150728}{-0{,}577911 + 0{,}5} = -0{,}378047$

$d_1 = \dfrac{0{,}004254 - 0{,}686294}{-0{,}577911} = 1{,}180182$

$b = -0{,}378047(-0{,}577911) + 1{,}180182 = 1{,}39866$

$c = 0{,}004254$

$x_3 = 1{,}422084 - \dfrac{2(0{,}004254)}{1{,}34866 + \sqrt{1{,}34866^2 - 4(-0{,}378047)(0{,}004254)}}$

$x_3 = 1{,}419030$

$x_0 = 2$

$x_1 = 1{,}422084$

$x_2 = 1{,}419050$

$e = \left|\dfrac{1{,}419030 - 1{,}422084}{1{,}41930}\right| \cdot 100 = 0{,}2142\%$

3) $h_0 = 1{,}422084 - 2 = -0{,}577911$ $\quad f(x_0) = 0{,}686294$

$h_1 = 1{,}419030 - 1{,}422084 = -0{,}003054$ $\quad f(x_1) = f(1{,}422) = 0{,}004254$

$f(x_2) = f(1{,}4190) = \ln(1{,}419030^2) - 0{,}7 = -0{,}000025$

$d_0 = \dfrac{0{,}004254 - 0{,}686294}{-0{,}577911} = 1{,}180182$

$a = \dfrac{1{,}408029 - 1{,}180182}{-0{,}003054 - 0{,}577911} = -0{,}392198$

$d_1 = \dfrac{-0{,}000025 - 0{,}004254}{-0{,}003054} = 1{,}408029$

$b = -0{,}392198(-0{,}003054) + 1{,}408029 = 1{,}409221$

$c = -0{,}000025$

$x_3 = 1{,}419030 - \dfrac{2(-0{,}000025)}{1{,}409221 + \sqrt{1{,}409221^2 - 4(-0{,}392198)(-0{,}000025)}}$

$x_3 = 1{,}419068$

$e = \left|\dfrac{1{,}419068 - 1{,}419050}{1{,}419068}\right| \cdot 100 = 0{,}00127\%$

4) $h_0 = 1{,}419050 - 1{,}422084 = -0{,}003034$ $\quad f(x_0) = f(1{,}422) = 0{,}004254$

$h_1 = 1{,}419068 - 1{,}419050 = 0{,}000018$ $\quad f(x_1) = f(1{,}419) = 0{,}000025$

$f(x_2) = f(1{,}419068) = 0{,}0000006$

$$d_0 = \frac{-0{,}000025 - 0{,}004254}{-0{,}003034} = 1{,}408024$$

$$d_1 = \frac{0{,}0000006 + 0{,}000025}{0{,}000018} = 1{,}422222$$

$$a = \frac{1{,}422222 - 1{,}408024}{0{,}000018 - 0{,}003034} = -4{,}648113$$

$$b = -4{,}648113(0{,}000018) + 1{,}422222 = 1{,}442137$$

$$c = 0{,}0000006$$

$$x_3 = 1{,}419068 - \frac{2(0{,}0000006)}{1{,}422137 + \sqrt{1{,}422137^2 - 4(-4{,}648113)(0{,}0000006)}}$$

$$x_3 = 1{,}419068$$

$$e = \left| \frac{1{,}419068 - 1{,}419068}{1{,}419068} \right| \cdot 100 = 0\%$$

2) La velocidad v de un paracaidista que cae esta dada por $v = \frac{gm}{c}\left(1 - e^{-(c/m)t}\right)$ donde $g = 9.8\ m/s^2$. Para un paracaidista con coeficiente de arrastre de $c = 15\ kg/s$ calcule la masa m de modo que la velocidad sea $v = 35\ m/s$ en $t = 9s$

$$35 = \frac{9.8}{15} m \left(1 - e^{-15/m \cdot 9}\right)$$

$$f(m) = \frac{9.8}{15} m \left(1 - e^{-135/m}\right) - 35$$

Método Bisección

Iteración	x_i	x_s	x_r	Error %
1	50	60	55	100%
2	55	60	57,5	4,35%
3	57,5	60	58,75	2,13%
4	58,75	60	59,375	1,05%
5	59,375	60	59,6875	0,52%

$$f(50) = \frac{9.8}{15}(50)\left(1 - e^{-\frac{135}{m}}\right) - 35$$

$$f(50) = -4,528713$$

$$f(60) = \frac{9.8}{15}(60)\left(1 - e^{-\frac{135}{m}}\right) - 35$$

$$f(60) = 0,062350$$

(1) $x_r = \frac{50+60}{2} = 55$

$$e = \left|\frac{55-0}{55}\right| 100 = 100\%$$

$$f(55) = \frac{9.8}{15}(55)\left(1 - e^{-\frac{135}{55}}\right) - 35 = -2,153420$$

(2) $x_r = \frac{55+60}{2} = 57,5$

$$e = \left|\frac{57,5-55}{57,5}\right| \cdot 100 = 4,35\%$$

$$f(57,5) = \frac{9.8}{15}(57,5)\left(1 - e^{-\frac{135}{57,5}}\right) - 35 = -1,023832$$

(3) $x_r = \frac{57,5+55}{2} = 58,75$

$$e = \left|\frac{58,75-57,5}{58,75}\right| \cdot 100 = 2,13\%$$

$$f(58,75) = \frac{9.8}{15}(58,75)\left(1 - e^{-\frac{135}{58,75}}\right) - 35 = -0,473132$$

(4) $x_r = \frac{58,75-57,5}{2} = 59,375$

$$e = \left|\frac{59,375-58,75}{59,375}\right| \cdot 100 = 1,05\%$$

$$f(59,375) = \frac{9.8}{15}(59.375)\left(1 - e^{-\frac{135}{59,375}}\right) - 35 = -0.201247$$

(5) $x_r = \frac{59,375+58,75}{2} = 59,6875$

$$e = \left|\frac{59,6875-59,375}{59,6875}\right| \cdot 100 = 0,52\%$$

Método de la Regla Falsa

Iteración	x_i	x_s	x_r	$f(x_i)$	$f(x_s)$	$f(x_r)$	Error %
1	50	60	59,851317	-4,528713	0,062350	0,004422	100 %
2	50	59,851317	59,841708	-4,528713	0,004422	0,000286	0,016 %
3	50	59,841708	59,841087	-4,528713	0,000286	0,000018	0,001 %
4	50	59.841087	59.841047	-4,528713	0,000018	0,0000012	0,00006%
5	50	59,841047	59,841045	-4,528713	0,0000012	0,00000008	0,000004%

$f(x_i) = f(50) = -4,528713$
$f(x_s) = f(60) = 0,062350$

(1) $x_r = \dfrac{60(-4,528713) - 50(0,062350)}{-4,528713 - 0,062350} = 59,851317$

$e = \left|\dfrac{59,851317 - 0}{59,851317}\right| \cdot 100 = 100\%$

$f(59,851317) = 0,004422$

(2) $x_r = \dfrac{59,851317(-4,528713) - 50(0,004422)}{-4,528713 - 0,004422} = 59,841708$

$e = \left|\dfrac{59,841708 - 59,851317}{59,841708}\right| \cdot 100 = 0,016\%$

$f(59,841708) = 0,000286$

(3) $x_r = \dfrac{59,841708(-4,528713) - 50(0,000286)}{-4,528713 - 0,000286} = 59.841087$

$e = \left|\dfrac{59.841087 - 59.841708}{59.841087}\right| \cdot 100 = 0,001\%$

$f(59,841087) = 0,000018$

(4) $x_r = \dfrac{59.841087(-4,528713) - 50(0,000018)}{-4,528713 - 0,000018} = 59,841047$

$e = \left|\dfrac{59.841047 - 59.841087}{}\right| \cdot 100 = 0,00006\%$

$f(59,841047) = 0,0000012$

(5) $x_r = \dfrac{59.841047(-4,528713) - 50(0,0000012)}{-4,528713 - 0,0000012} = 59,841045$

$e = \left|\dfrac{59,841045 - 59.841047}{59,841045}\right| \cdot 100 = 0,000004\%$

$f(59,841045) = 0,00000008$

Método Newton Raphson

Iteración	x_i	x_{i+1}	Error %
1	50	59,225803	15,58%
2	59,225803	59,838495	1,02 %
3	59,838495	59,841046	0,0043%
4	59,841046	59,841045	0,0000002%
5	59,841045	59,841044	0,0000017%

$$f(m)=\frac{9.8}{15}m\left(1-e^{-\frac{135}{m}}\right)-35$$

$$f'(m)=\frac{9.8}{15}-\left(\frac{49m+6615}{75m}\right)e^{-\frac{135}{m}}$$

① $i=1$

$$f'(50)=\frac{9,8}{15}-\left(\frac{49(50)+6615}{75(50)}\right)e^{-\frac{135}{50}}=0,490875$$

$$f(50)=\frac{9,8}{15}(50)\left(1-e^{-\frac{135}{50}}\right)-35=-4,528713$$

$$x_2=50-\frac{-4,528713}{0,490875}=59,225803$$

$$e=\left|\frac{59,225803-50}{59,225803}\right|\cdot 100=15,58\%$$

② $i=2$

$$f(59,225803)=\frac{9.8}{15}(59,225803)\left(1-e^{-\frac{135}{59,225803}}\right)-35=-0,265942$$

$$f'(59,225803)=\frac{9,8}{15}-\left(\frac{49(59,225803)+6615}{75(59,225803)}\right)e^{-\frac{135}{59,225803}}=0,434055$$

$$x_3=59,225803-\frac{-0,265942}{0,434055}=59,838495$$

$$e=\left|\frac{59,838495-59,225803}{59,838495}\right|=1,02\%$$

③ $i=3$

$$f(59,838495)=\frac{9,8}{15}(59,838495)\left(1-e^{-\frac{135}{59,838495}}\right)-35=-0,001098$$

$$f'(59,838495)=\frac{9.8}{15}-\left(\frac{49(59,838495)+6615}{75(59,838495)}\right)e^{-\frac{135}{59,838495}}=0,430475$$

$$x_4=59,838495-\frac{-0,001098}{0,430475}=59,841046$$

$$e=\left|\frac{59,841046-59,838495}{59,841046}\right|=0,0043\%$$

④ $i=4$

$$f(59,841046)=\frac{9.8}{15}(59,841046)\left(1-e^{-\frac{135}{59,841046}}\right)-35=0,0000005$$

$$f'(59,838495)=\frac{9.8}{15}-\left(\frac{49(59,841046)+6615}{75(59,841046)}\right)e^{-\frac{135}{59,841046}}=0,430460$$

$$x_5=59,841046-\frac{0,0000005}{0,430460}=59,841045$$

$$e=\left|\frac{59,841045-59,838495}{59,841045}\right|=0,0000002\%$$

⑤ $i=5$

$$f(59,841045)=\frac{9,8}{15}(59,841046)\left(1-e^{-\frac{135}{59,841046}}\right)-35=0,000000108$$

$$f'(59,841045)=\frac{9,8}{15}-\left(\frac{49(59,841045)+6615}{75(59,841046)}\right)e^{-\frac{135}{59,841045}}=-0,134923$$

$$x_6=59,841045-\frac{0,000000108}{-0,134923}=59,841044$$

$$e=\left|\frac{59,841044-59,841045}{59,841044}\right|=0,0000017\%$$

Método de la Secante

Iteración	x_i	x_{i-1}	x_{i+1}	Error %
1	60	50	59,851318	0.24%
2	59,851318	60	59,837100	0,024%
3	59,837100	59,851318	59,84025	0,005%
4	59,840250	59,837100	59,841045	0,001%
5	59,841045	59,840250	59,841045	0

$f(50) = -4,528713$ $f(60) = 0,068350$

①

$$x_2 = \frac{60(-4,528713) - 50(0,06835)}{-4,528713 - 0,068350} = 59,851318$$

$$e = \left| \frac{59,851318 - 60}{59,851318} \right| = 0,24\%$$

②

$$f(x_{i+1}) = f(59,851318) = \frac{9,8}{15}(59,851318)\left(1 - e^{-\frac{135}{59,851318}}\right) - 35 = 0,005966$$

$$x_3 = \frac{59,851318(0,068350) - 60(0,005966)}{0,068350 - 0,005966} = 59,837100$$

$$e = \left| \frac{59,837100 - 59,851318}{59,837100} \right| \cdot 100 = 0,024\%$$

③

$$f(x_{i+1}) = f(59,837100) = \frac{9,8}{15}(59,837100)\left(1 - e^{-\frac{135}{59,837100}}\right) - 35 = -0,001698$$

$$x_4 = \frac{59,837100(0,005966) - 59,851318(-0,001698)}{0,005966 + 0,001698} = 59,840250$$

$$e = \left| \frac{59,840250 - 59,837100}{59,840250} \right| \cdot 100 = 0,005\%$$

④

$$f(x_{i+1}) = f(59,840250) = \frac{9,8}{15}(59,840250)\left(1 - e^{-\frac{135}{59,840250}}\right) - 35 = -0,000342$$

$$x_5 = \frac{59,840250(-0,001698) - 59,837100(-0,000342)}{-0,001698 + 0,000342} = 59,841045$$

$$e = \left| \frac{59,841045 - 59,840250}{59,841045} \right| = 0,001\%$$

⑤

$$f(x_{i+1}) = f(59,841045) = \frac{9,8}{15}(59,840250)\left(1 - e^{-\frac{135}{59,841045}}\right) - 35 = -0,000000108$$

$$x_6 = \frac{59,841045(-0,000342) - 59,840250(-0,000000108)}{-0,000342 + 0,000000108} = 59,841045$$

$$e = \left| \frac{59,841045 - 59,841045}{59,841045} \right| \cdot 100 = 0$$

Método de Müller

$f(m)=\frac{9.8}{15}m\left(1-e^{-\frac{135}{m}}\right)-35$ $\quad x_0=20 \quad x_1=30 \quad x_2=60$

Iterac	x_0	x_1	x_2	x_3	Error %
1	20	30	60	59,8444881	0,259%
2	30	60	59,844881	59,841045	0,0064%
3	60	59,844881	59,841045	59,841045	0%

(1) $h_0=x_1-x_0=30-20=10$

$h_1=x_2-x_1=60-30=30$

$f(20)=\frac{9.8}{15}(20)\left(1-e^{-\frac{135}{20}}\right)-35=-21,948632$

$f(30)=\frac{9.8}{15}(30)\left(1-e^{-\frac{135}{30}}\right)-35=-15,617736$

$f(60)=\frac{9.8}{15}(60)\left(1-e^{-\frac{135}{60}}\right)-35=0,068350$

$d_0=\frac{f(x_1)-f(x_0)}{h_0}=\frac{-15,617736+21,948632}{10}=0,6330896$

$d_1=\frac{f(x_2)-f(x_1)}{h_1}=\frac{0,068350+15,617736}{30}=0,5228695$

$a=\frac{d_1-d_0}{h_1+h_0}=\frac{0,5228695-0,6330896}{10+30}=-0,0027555$ $\qquad c=0,068350$

$b=ah_1+d_1=-0,0027555(30)+0,5228695=0,440204$

$x_3=x_2-\frac{2c}{b\pm\sqrt{b^2-4ac}}=60-\frac{2(0,068350)}{0,440204+\sqrt{0,440204^2-4(-0,0027555)(0,068350)}}=59,844881$

$e=\left|\frac{59,844881-60}{59,844881}\right|\cdot100=0,259\%$

(2) $h_0=60-30=30$

$h_1=59,844881-60=-0,155119$

$f(x_0)=f(30)=-15.617736$

$f(x_1)=f(60)=0,068350$

$f(x_2)=f(59,844881)=\frac{9.8}{15}(59.84)\left(1-e^{-\frac{135}{59,84}}\right)-35=0,001651$

$d_0=\frac{0,068350+15,617736}{30}=0,522869$

$d_1=\frac{0,001651-0,068350}{-0,155119}=0,429986$

$a=\frac{0,429986-0,522869}{30-0,155119}=-0,003112$ $\qquad c=0,001651$

$b=-0,003112(-0,155119)+0,429986=0,430469$

$x_3=59,844881-\frac{2(0,001651)}{0,430469+\sqrt{0,430469^2-4(-0,003112)(0,001651)}}=59,841045$

$e=\left|\frac{59,841045-59,844881}{59,841045}\right|\cdot100=0,0064\%$

③ $h_0 = -0,155119$

$h_1 = 59,844881 - 60 = -0,003836$

$f(x_0) = f(60) = 0,068350$

$f(x_1) = f(59,844881) = 0,001651$

$f(x_2) = f(59,841045) = \frac{9.8}{15}(59,841045)\left(1 - e^{-\frac{135}{59,841045}}\right) - 35$

$= 1.239776$

$d_0 = \frac{0,001651 - 0,068350}{-0,155119} = 0,429987$

$d_1 = \frac{1,239776 - 0,001651}{-0,003836} = 0,430449$

$a = \frac{0,430449 - 0,49987}{-0,003836 + 0,155119} = -0,002909$

$C = 1,239776$

$b = -0,002909(-0,003836) + 0,430449 = 0,430460$

$x_3 = 59,841045 - \frac{2(1,239776)}{0,430460 + \sqrt{0,430460^2 - 4(-0,002909)(1,239776)}} = 59.841045$

$e = \left|\frac{59,841045 - 59,841045}{59,841045}\right| \cdot 100 = 0$