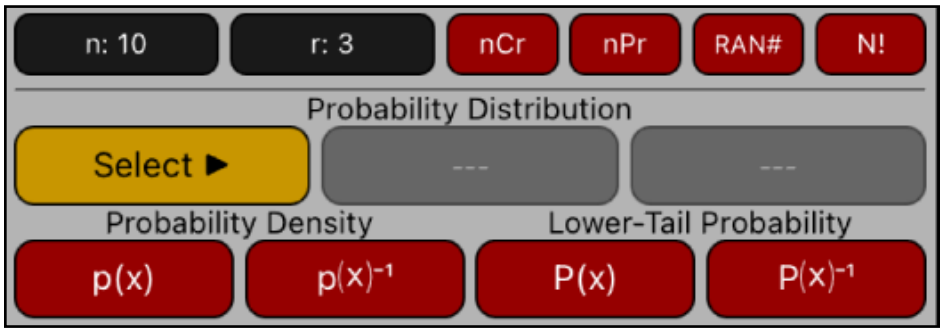
Probability Worksheet



This worksheet allows the calculations of combinations, permutations, random numbers, factorial and probabilities of selected distributions.

Probability Menu Actions	
[n]	Stores the number of total items.
[r]	Stores the number of items to be taken at a time.
[nCr]	Calculates the number of combinations. **nCr = n! / [r! • (n - r)!]**
[nPr]	Calculates the number of permutations. **nPr = n! / (n - r)!**
[RAN#]	Enters a random number in the range $0 \leq x < 1$
N!	Calculates the factorial of the displayed number.
[Select ▶] Exponential Normal t-Student Weibull	Select one of the available Probability Distribution.
[p(x)]	Calculates the probability density of the displayed number.
[$p(x)^{-1}$]	Calculates the inverse probability density of the displayed number.
[P(x)]	Calculates the lower-tail cumulative probability of the displayed number.
[$P(x)^{-1}$]	Calculates the inverse lower-tail cumulative probability of the displayed number.

Example: Combinations

Using 10 colored balls, how many different color combinations of three balls can be chosen?

Keystrokes	Description
10 **[n]**	Type the number of total items (10 colored balls).
3 **[r]**	Type the size os the sample (3 balls)
[nCr]	Calculate the number of possible combinations. **Result = 120.00**

Example: Permutations

Using 5 books labeled A, B, C, D and E, how many different ways can three books be placed on a shelf?

Keystrokes	Description
5 **[n]**	Type the number of total items (5 books).
3 **[r]**	Type the size os the sample (3 books).
[nPr]	Calculate the number of possible permutations. **Result = 60.00**

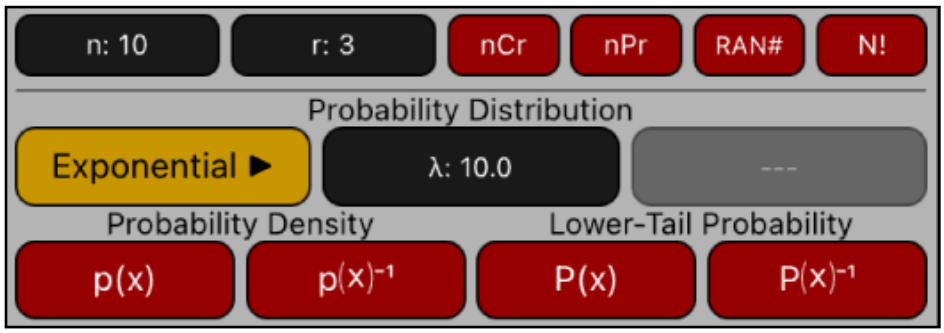
Example: Random Number Generator

Store a seed value of 42 and generate a sequence of 5 random numbers.

Keystrokes	Description
42 **[STO]** **[RAN#]**	Store the initial random seed.
[RAN#]	Generate the 1st random number. **Result = 0.1708**
[RAN#]	Generate the 2nd random number. **Result = 0.7499**
[RAN#]	Generate the 3rd random number. **Result = 0.0964**
[RAN#]	Generate the 4th random number. **Result = 0.8705**
[RAN#]	Generate the 4th random number. **Result = 0.5773**

The following examples assumes the “Probability” menu is already visible in the calculator and the display format is set to 6 decimal places.

Exponential Probability Distribution



When the Exponential probability density function is selected, the distribution "rate parameter" (λ) can be entered in the corresponding button.

The Probability Density Function is: **p(x) =** $\lambda e^{-\lambda x}$

Example: Exponential Distribution

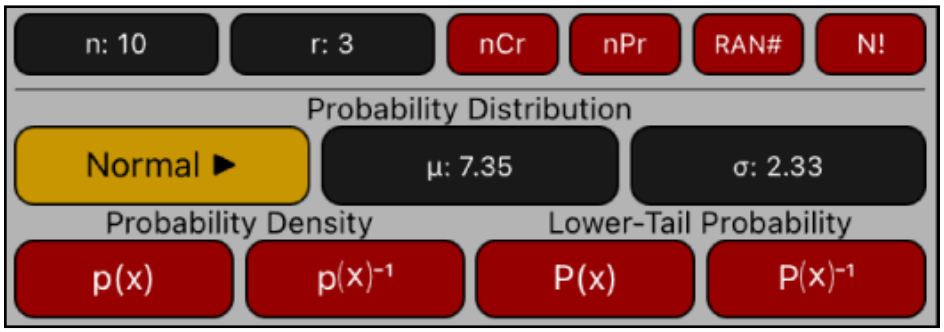
Consider an Exponential random variable with a rate of 10.

1. What is the probability for a value equal to 0.2 => p(0.2) = ?
2. If the probability is 5%, what is the value => $p^{-1}(0.05)$ = ?
3. What is the probability of a value ≤ 0.2 => P(x ≤ 0.2) = ?
4. What is the value 'z' for probability of x ≤ z is 5% => $P^{-1}(x \le z) = 0.05$?

Solution:

Keystrokes	Description
Distribution **[Exponential ▶]**	Select the Exponential Probability Distribution
10 **[λ]**	Type the distribution rate and enter it.
0.2 **[p(x)]**	1) Calculate the probability. **Result = 1.353353**
0.05 **[$p(x)^{-1}$]**	2) Calculate the z-value. **Result = 0.529832**
0.2 **[P(x)]**	3) Calculate the probability. **Result = 0.864665**
0.05 **[$P(x)^{-1}$]**	4) Calculate the z-value. **Result = 0.005129**

Normal Probability Distribution



When the Normal probability density function is selected, the distribution "mean" (μ) and standard deviation (σ) can be entered in the corresponding buttons.

The Probability Density Function is: **p(x) =** $\frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$

Example: Normal Distribution

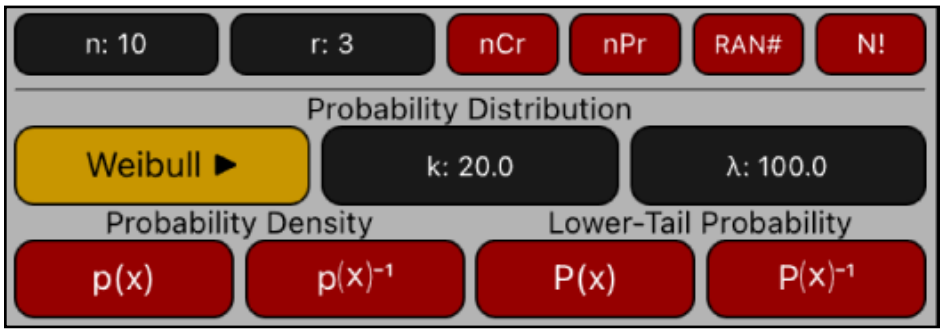
Consider a Normal random variable with a mean of 7.35 and a standard deviation of 2.33.

1. What is the probability for a value equal to 5.35 => p(5.35) = ?
2. IF the probability is 5%, what is the value => $p^{-1}(0.05)$ = ?
3. What is the probability of a value ≤ 5.35 => P(x ≤ 5.35) = ?
4. What is the value 'z' for probability of x ≤ z is 5% => $P^{-1}(x \le z) = 0.05$?

Solution:

Keystrokes	Description
Distribution [Normal ▶]	Select the Normal Probability Distribution
7.35 **[μ]**, 2.33 **[σ]**	Input the distribution mean and standard deviation.
5.35 **[p(x)]**	1) Calculate the probability. **Result = 0.118457**
0.05 **[p(x)$^{-1}$]**	2) Calculate the z-value. **Result = 11.005837**
5.35 **[P(x)]**	3) Calculate the probability. **Result = 0.195344**
0.05 **[P(x)$^{-1}$]**	4) Calculate the z-value. **Result = 3.517491**

Weibull Probability Distribution



When the Weibull probability density function is selected, the distribution "shape" parameter (k) and the "scale" parameter (λ) can be entered in the corresponding buttons.

The Probability Density Function is: **p(x) =** $\frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1} e^{-(x/\lambda)^k}$

Example: Weibull Distribution

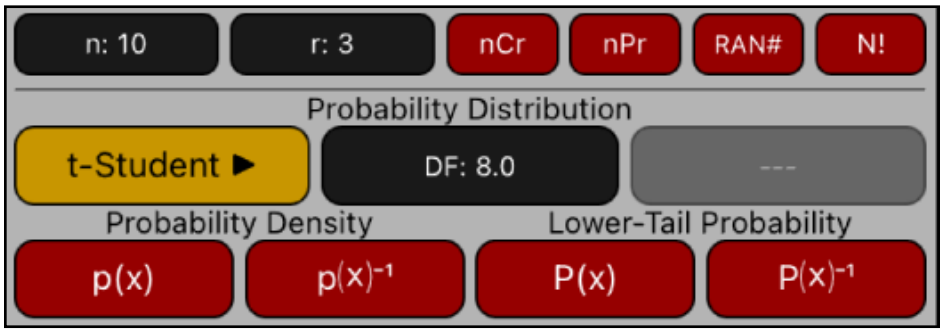
Consider a Weibull random variable with a shape factor of 20 and a scale factor of 100.

1. What is the probability for a value equal to 105 => p(105) = ?
2. If the probability is 5%, what is the value => $p^{-1}(0.05)$ = ?
3. What is the probability of a value ≤ 90 => P(x ≤ 90) = ?
4. What is the value 'z' for probability of x ≤ z is 5% => $P^{-1}(x \le z) = 0.05$?

Solution:

Keystrokes	Description
Distribution **[Weibull ▶]**	Select the Weibull Probability Distribution
20 **[k]**, 100 **[λ]**	Input the shape (k) and scale (λ) parameters of the distribution.
105 **[p(x)]**	1) Calculate the probability. **Result = 0.035589**
0.05 **[p(x)$^{-1}$]**	2) Calculate the z-value. **Result = 94.584178**
90 **[P(x)]**	3) Calculate the probability. **Result = 0.114477**
0.05 **[P(x)$^{-1}$]**	4) Calculate the z-value. **Result = 86.199159**

t-Student Probability Distribution



When the t-Student probability density function is selected, the distribution "Degrees of Freedom" parameter (DF) can be entered in the corresponding button.

The Probability Density Function is: **p(x) =** $$\frac{\Gamma(\frac{\nu+1}{2})}{\sqrt{\nu\pi}\,\Gamma(\frac{\nu}{2})}\left(1+\frac{t^2}{\nu}\right)^{-\frac{\nu+1}{2}}$$

Example: Weibull Distribution

Consider a t-Student random variable with 8 degrees of freedom.

1. What is the probability for a value equal to 0.5 => p(0.5) = ?
2. If the probability is 5%, what is the value => $p^{-1}(0.05)$ = ?
3. What is the probability of a value ≤ 0.5 => P(x ≤ 0.5) = ?
4. What is the value 'z' for probability of x ≤ z is 5% => $P^{-1}(x \le z) = 0.05$?

Solution:

Keystrokes	Description
Distribution [t-Student ▶]	Select the t-Student Probability Distribution
8 **[DF]**	Input the distribution degrees of freedom.
0.5 **[p(x)]**	1) Calculate the probability. **Result = 0.336694**
0.05 **[p(x)$^{-1}$]**	2) Calculate the z-value. **Result = 2.145724**
0.5 **[P(x)]**	3) Calculate the probability. **Result = 0.684732**
0.05 **[P(x)$^{-1}$]**	4) Calculate the z-value. **Result = -1.859548**