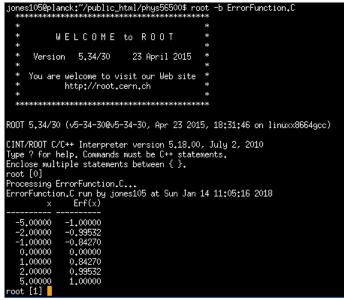
## Physics 56500 Assignment #1 – Due January 23<sup>rd</sup>

 First, to verify that you have access to ROOT, download the macro called "ErrorFunction.C" from the Phys56500 web site, and verify that it yields the following output:



2. Show that the cumulative probability distribution for a Gaussian p.d.f.

$$g(x;\mu,\sigma) = \frac{1}{\sqrt{2\pi\sigma}} e^{-(x-\mu)^2/2\sigma^2}$$

can be written,

$$G(x;\mu,\sigma) = \frac{1}{2} \left( 1 + \operatorname{erf}\left(\frac{x-\mu}{\sigma\sqrt{2}}\right) \right).$$

3. If the random variable X is drawn from a Gaussian p.d.f., calculate the probability that
(a) x > μ - 5σ, x > μ - 2σ, x > μ - σ, x > μ, x > μ + σ, x > μ + 2σ, x > μ + 5σ
(b) |x - μ| < 5σ, |x - μ| < 2σ, |x - μ| < σ</li>

4. The  $\chi^2$  statistic for two correlated measurements,  $y_1 \pm \sigma_1$  and  $y_2 \pm \sigma_2$ , with correlation coefficient,  $\rho$ , is written:

$$\chi^2 = (m - y_1 \quad m - y_2) \begin{pmatrix} \sigma_1^2 & \rho \sigma_1 \sigma_2 \\ \rho \sigma_1 \sigma_2 & \sigma_2^2 \end{pmatrix}^{-1} \begin{pmatrix} m - y_1 \\ m - y_2 \end{pmatrix}.$$

(a) Show that the value of m that minimizes  $\chi^2$  is

$$\widehat{m} = \frac{y_1(\sigma_2^2 - \rho \sigma_1 \sigma_2) + y_2(\sigma_1^2 - \rho \sigma_1 \sigma_2)}{\sigma_1^2 - 2\rho \sigma_1 \sigma_2 + \sigma_2^2}$$

(b) Show that the variance in  $\widehat{m}$  is

$$\sigma_{\hat{m}}^2 = \frac{\sigma_1^2 \sigma_2^2 (1 - \rho^2)}{\sigma_1^2 - 2\rho \sigma_1 \sigma_2 + \sigma_2^2}.$$