

## Reliability Analysis with Root-Finding Model

Let the response,  $u$ , of an engineering system be defined by the root of the equation

$$x_1 \cdot u^5 + x_2 \cdot u^3 + x_3 \cdot u^2 - x_4 = 0$$

The four coefficients in this equation are uncertain. They are modeled as lognormal random variables with 10% coefficients of variation and the following means:

$$\mu_1 = 1$$

$$\mu_2 = 2$$

$$\mu_3 = 0.2$$

$$\mu_4 = 10$$

Failure of the system is expected if  $u$  exceeds 1.7. However, this limit is also uncertain. It is modeled as a lognormal random variable, also with 10% coefficient of variation. The first two coefficients in Eq. (1) are assumed to be correlated by  $\rho = 0.5$ , while the first and last coefficients are negatively correlated by  $\rho = -0.5$ . The other variables are assumed to be uncorrelated.

Compute the probability of failure for this system by FORM, and rank the random variables according to their relative importance. Also point out which variable act as “resistance” variables and which act as “load” variables. The code must solve for the root of the equation above. The root of a nonlinear equation can be found by the iterative Newton algorithm:

$$u_{i+1} = u_i - \frac{f(u_i)}{f'(u_i)}$$

where  $f$  is the left-hand side of the equation above and  $f'$  denotes the derivative of  $f$  with respect to  $u$ . **Rt** has a built-in model to find the root of a nonlinear equation.