ME 615: Design Under Uncertainty
Prof Hoyle, Spring 2020
HW 3

Assigned: 4/23/2020
Due: 5/6/2020 (on CANVAS)

1. For the Motor Design problem, use the First Order Reliability method (**FORM**) to compute the probably of meeting a requirement that weight < 22 kgs. Use the following uncertain parameters:
    - D ~ N(7.5,0.5)
    - L ~ N(9.5,0.5)
    - dcu ~ N(8.94e3, 100)
    - dfe ~ N(7.98e3, 100)

    Note that for the FORM algorithm the constraint must be in Positive Null form, so you will have to modify the motor design file to put the motor weight equation into positive null form.
2. Repeat problem 1 but use the **Full Tensor Numerical Integration** Method. Use 3 nodes per uncertain input. Again the uncertainties are (the variables are independent, i.e. 0 correlation):
    - D ~ N(7.5,0.5)
    - L ~ N(9.5,0.5)
    - dcu ~ N(8.94e3, 100)
    - dfe ~ N(7.98e3, 100)
3. Repeat problem 2, but use the following distributions for uncertainty:
    - D ~ Uniform(6.5, 8.5)
    - L ~ Uniform (8.5, 10.5)
    - dcu ~ Uniform (8840, 9040)
    - dfe ~ Uniform (7880, 8080)

For this problem, the following are also Matlab is also supplied:

- pearscdf.m: This function takes as arguments the following:
    - limits: the lower and upper limit of integration vector: [lower, upper]. An upper of lower limit can be specified as INF or –INF.
    - mu, sigma, skew, kurt: The mean, standard deviation, skewness, and kurtosis.

    pearscdf.m returns the probability of meeting a requirement and plots the results.
- Compecon2011 toolbox: in it you will find:
    - qnwnorm.m: Multivariate normal x and w.
    - qnwlogn.m: Multivariate lognormal x and w.
    - qnwunif.m: Univariate uniform x and w.
    - qnwbeta.m: Univariate beta x and w.

For Python:

- Pears_cdf.py (Contributed by Annalise Miller 2018): Works similar to the matlab pearscdf.m
- For the gaussian quadrature, you can use:
    - numpy.polynomial.hermite.hermgauss (Normal Variables)
    - numpy.polynomial.legendre.leggauss (Uniform Variables)