1. The problem solved in reliability can be solved using simulations as follows. The following are the variables with the values of parameters along with the performance function.

Performance function g(X1, X2, X3) = 7.5*X1*X2 – X3.

RANDOM VARIABLE	UNIT	MEAN	COEFFICIENT OF VARIATION	STANDARD DEVAITAION
Normal Discharge X1	Cubic m/s	22	0.22	4.4
Normal Hydraulic Head X2	M	5.2	0.15	0.78
Normal Power Demand X3	kW	600	0.10	60

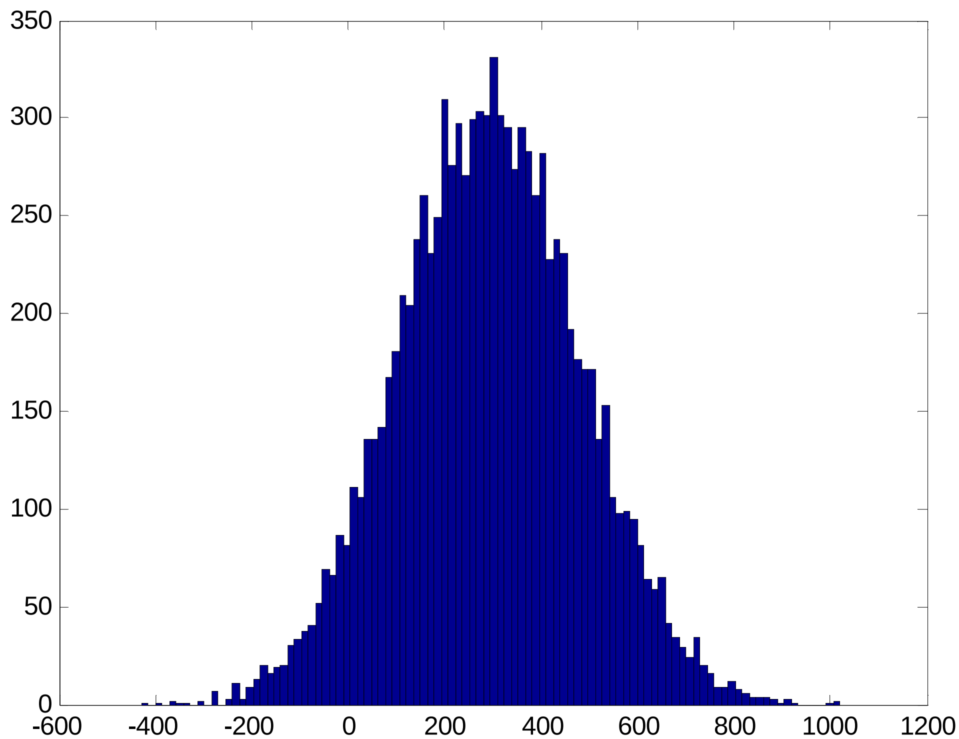
The MATLAB program with the following commands is used to evaluate probability of failure. Number of simulations is taken as 100000 and all the three variables are normally distributed.

```
n = 10000;
x1 = ( randn(n,1) * 4.4) + 22;
x2 = (rand(n,1)*0.78)+5.2;
x3=(rand(n,1)*60)+600;
y = 7.5.*x1.*x2-x3;
hist(y,100);
y_mean = mean(y)
y_std = std(y)
beta1 = y_mean/y_std
pf = normcdf(-beta1,0,1)
```

<u>Answer:</u>

Probability density distribution of G is shown in Figure. Mean value of performance function G_mean =292.8984   G_std = 188.5695

Reliability index and probability of failure are 1 .5533 and 0.0602 respectively which is close to the result obtained in the previous case.



Consider the harbor breakwater problem in the previous case. It is necessary to evaluate the risk that the breakwater will slide under pressure of a large wave during major storm.

Resultant horizontal force, $\mathbf{R_{h}}$, depends on the balance between the static and dynamic pressure components, and it can be taken as quadratic function of H_b under simplified hypothesis on the depth of the breakwater.

Random deep water value $\mathbf{X_4 = H_s}$, which is found from frequency analysis of extreme storms in the area.

Resultant vertical force, $\mathbf{R_v = X_2 - F_V}$

Where $\mathbf{X_2}$, weight of the tank reduced for buoyancy.

$\mathbf{F_V}$, a vertical component of dynamic uplift pressure due to the braking wave. It is proportional to height of the height of the design wave, H_b, when the slope of sea bottom is known.

Coefficient of friction, $\mathbf{c_f}$, can interpret as a random variable, $\mathbf{X_1}$, which represents inherent uncertainty associated with its field evaluation.

$if\ {Rh}/{Rv} < c_f$, stability against sliding will exist.

Additional variate X_3 is introduced to represent the uncertainties caused the simplifications adopted to model the dynamic forces F_V and R_h .

Simplification of the shoaling effects indicates that the height H_b of the design wave is proportional to random deepwater value X_4.

All random variables are assumed to be independent.

The constants a_1, a_2, a_3 are depends on geometry of system.

Accounting for the sea-bottom profile and the geometry, one estimate constants, a_1=7, a_2 =17m/KN, a_3=145.

Limiting state equation

$$g(X_1, X_2,X_3.X_4) = X_1X_2- 70X_1X_3X_4 -17X_3X_4 -17X_3X_4X_4 -145X_3X_4 = 0 \qquad (1)$$

Random variables	Mean	Coefficient of variation	Standard deviation
X_1	0.64	0.15	0.096
X_2	3400 KiloNewton/m	0.05	108.80
X_3	1	0.20	0.2
X_4	5.16	0.18	0.93

Solution: calculation of reliability index using Monte Carlo simulation

All random variables are in normal distribution.

Mean of y =340.4513

Standard deviation of y =327.4135

Reliability index =1.0398

Risk =0.1492