RISK MANAGEMENT

Meaning:-

Risk Management is defined as the process of identifying, monitoring and managing potential risks in order to minimize the negative impact they may have on an organisation.

Examples:-

1) Security Breaches
2) Data loss
3) Cyber attacks
4) System failures

5) Natural Disasters

⇒ **Risk Management Process :- / Framework :**

1) Set Policies & Procedures for risk governance.

2) Define Risk Tolerance limit
   → willingness & ability to take the risk.

3) **Identify Potential Risk :-**
   (Financial & Non-financial risk)

(i) Strategic Risk
(ii) Compliance Risk / Legal Risk
(iii) Operational Risk

(iv) Financial Risk

(a) Counterparty Risk / Credit Risk

(b) Political Risk

(c) Interest Rate Risk

(d) Currency Risk

4) **Quantify the risk :-** (Using VAR) **

5) Adjust the risk using Hedging Techniques.

Measures of Risk :-

S.D | Beta | Delta | Duration | Vega |

Gamma | Rho

Interpretation of VAR:- Value-at-Risk

Var states at some probability (often 1% or 5%), the minimum loss during a specified time period.

The loss can be stated as % of Value or as a Nominal Amt.

VAR has a dual interpretation.

Example:-

A $100 million Portfolio has a 1.5% VAR at 5% Probability over 1 week.

(i) Cal what could be the loss?

(ii) Explain what the loss means?

Solⁿ:- Over one week, the portfolio could lose 1.5% of \$100 million or \$1.5 million

(1) There is a 5% Probability that more than \$1.5 million will be lost in 1 week.

or

In 5% of the worst situation, minimum possible weekly loss is \$1.5 million

(2) 95% Probability that less than \$1.5 million will be lost in one week.

or

We are 95% confident that the maximum possible loss would be $1.5 million.

VAR is not Expected loss.

Example:

The Daily 5% VAR is $15000.

(i) ⇒ It indicates that there is 5% chance that on any day, the Portfolio will experience a loss of $15000 or more.

⇒ (2) There is 95% chance that on any given day the portfolio will experience a loss less than $ 15000 or a gain.

Note:- Analyst should consider some additional issues with VAR:-

1) The VAR time period should be related to the nature of the situation

(a) Stocks & Bonds portfolio would likely focus on a longer monthly or quarterly VAR.

(b) Highly leveraged derivatives portfolio might focus on a shorter daily VAR

2) The % (percentage) selected

will effect the VAR.

At 1% VAR would be expected to show greater risk than 5% VAR.

3) The left tail should be examined.
(Standard Normal Distribution)

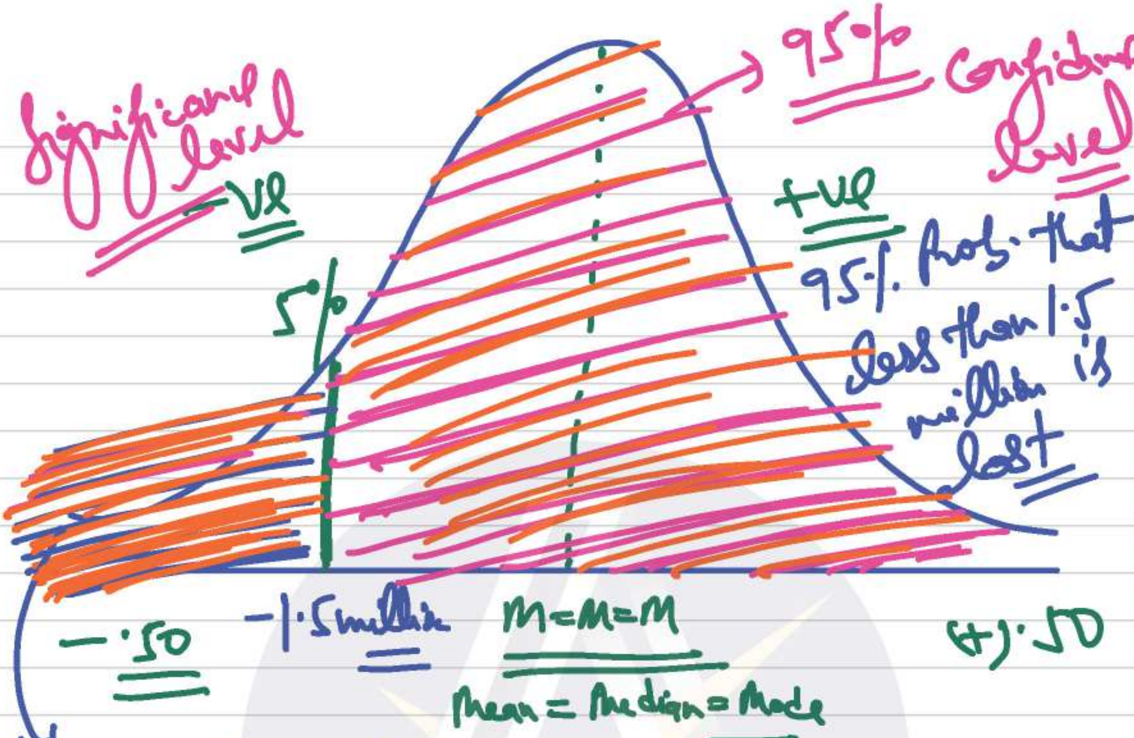
The left tail displays the lower or negative returns.

VAR

1) Time Frame
Eg:- Day | week | month

2) Significance level
1% | 5% | 10%

3) Loss Amt.
% | $ | ₹



5% Prob. that loss exceeds 1.5 million

Case I

When Expected Return Value is Zero:-

Cal. of VAR

Relative VAR

(%)

Z-Value (X%) × S.D (σ)

⇒ VAR$_{X\%}$ (%)

Absolute VAR

(Amount)

Z Value$_{X\%}$ × S.D (σ) × Asset Value

or

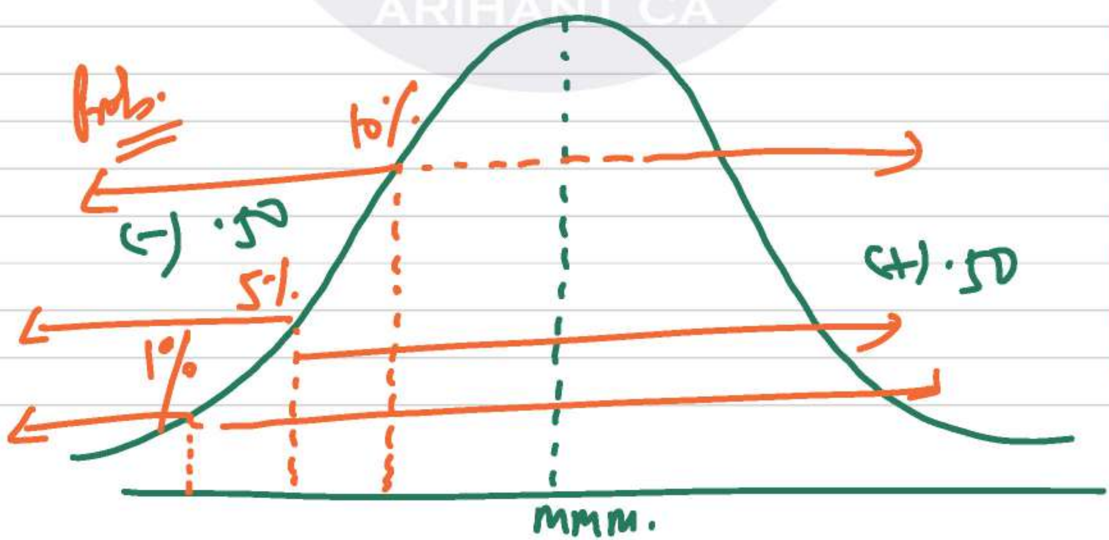
VAR$_{X\%}$ × Asset Value

⇒ VAR (Amount)

where, Z-value corresponding with the desire level of significance.

(σ) = S.D. of returns

Significance level	Confidence level	Z-Value
1%	99%	2.33 ①
2.5%	97.5%	1.96
5%	95%	1.65 ②
10%	90%	1.28



-2.33 -1.65 -1.28 Z-Value

Example:-

A risk management officer at a Bank is interested in calculating the VAR of an Asset that he is considering adding to the Bank's portfolio.

If the Asset has a Daily S.D. of returns equal to 1.4% & the Asset has a current value of $5.3 million. Cal. VAR (5%) on both a percentage & dollar basis.

Soln. $VAR_{(5\%)} \Rightarrow Z\text{-Value}_{5\%} \times S.D_{(\sigma)}$

$\Rightarrow 1.65 \times 1.4$

$\Rightarrow 2.31\%$

$VAR_{5\%}$ on a Dollar Basis:-

$\Rightarrow$ 2.31% × \$ 5.3 million

$\Rightarrow$ \$ 122430

Thus, there is a 5% probability that on any given day, the loss in value on this particular asset will equal or exceed 2.31% or \$ 122430

Case II:. If an Expected Return, other than Zero is given i.e. $\mu \neq 0$

VAR becomes:-

$$VAR = \left[E(R) - Z\text{-value} \times S.D_{(\sigma)}\right] \text{Asset Value}$$

Example:-

For a \$ 100,00,000 Portfolio, the Expected 1 week portfolio return & S.D are 0.00188 and 0.0125 respectively.

Calculate the 1-week VAR at 5% significance level.

Solⁿ: $VAR = \left[E(R) - \underset{(5\%)}{Z\text{-value}} \times \sigma\right] \times \text{Portfolio Value}$

$\Rightarrow \left[0.00188 - 1.65 \times 0.0125\right] \times \$100,00,000$

$\Rightarrow \$187450$

The Manager can be 95% confident that the maximum 1 week loss will not exceed \$ 187450

Note:- VAR Conversion:- (Square-root rule)

VAR can be converted from a 1 Day basis to a longer basis by multiplying the Daily VAR by the Square-root of the number of days in the longer time period is called the Square-root rule.

Example:- Convert Daily VAR into Weekly VAR:-

$\Rightarrow$ Daily VAR $\times \sqrt{5}$

(Assume 5 Business Days in a week)

Example: Annual VAR = 5,00,000

Daily VAR

$$\Rightarrow \frac{5,00,000}{\sqrt{250}}$$

$$\Rightarrow ₹\ 31623$$

(Assume 250 Trading Days in a year)

Example: If 10 Days VAR = 50,000

Cal. 60 Days VAR = ?

$$\Rightarrow \frac{50,000}{\sqrt{10}} \times \sqrt{60}$$

$$\Rightarrow ₹\ 122474$$

Example:

Assume that a risk manager has calculated the Daily VAR (10%) dollar Basis of a Particular Asset to be \$12500.

Calculate Weekly, Monthly, Semi-Annually & Annual VAR of this Asset.

Assume 250 Trading Days in a year, 50 weeks per year & 20 Days in a month.

Soln. $VAR_{(10\%)} \rightarrow$ 5 Days (Weekly)

$\Rightarrow \$12500 \times \sqrt{5}$

$\Rightarrow \$ \ 27951$

VAR(10%) 20 Days (Monthly)

$\Rightarrow \$ 12500 \times \sqrt{20}$

$\Rightarrow \$ 55902.$

VAR(10%) 125 Days

$\Rightarrow \$ 12500 \times \sqrt{125}$

$\Rightarrow \$ 139754$

VAR(10%) 250 Days:-

$\Rightarrow \$ 12500 \times \sqrt{250} \Rightarrow \$ 197642$

Note:- VAR can also be converted to different Confidence level:-

Example:-

If you want to Convert VAR with 95% Confidence level to VAR with 99% confidence level.

$$\boxed{VAR_{(1\%)} = \frac{VAR_{(5\%)}}{Z_{(5\%)}} \times Z_{(1\%)}}$$

Example:- Assume that a risk manager has calculated VAR at a 95% Confidence level to be $16500.

Now assume the risk manager wants to adjust the confidence level to 99%.

Cal. VAR at 99% Confidence level?

$$VAR_{1\%} \Rightarrow \frac{VAR_{5\%}}{Z_{(5\%)}} \times Z_{(1\%)}$$

$$\Rightarrow \frac{\$16500}{1.65} \times 2.33$$

$$VAR_{1\%} \Rightarrow \$23,300$$

Note: S.D. will be given, However, you may have to adjust it for time period.

S.D. is proportional to the square-root of time.

Eg.

$$\sigma_{Monthly} = \frac{\sigma_{annual}}{\sqrt{12}}$$

$$\sigma_{Day} \Rightarrow \frac{\sigma_{annual}}{\sqrt{250}}$$

$$\sigma_{week} \Rightarrow \frac{\sigma_{annual}}{\sqrt{52}}$$

$$\sigma_{10\ Days} \Rightarrow \sigma_{Daily} \times \sqrt{10}$$

$$\sigma_{Daily} \Rightarrow \frac{\sigma_{10\ Days}}{\sqrt{10}}$$

Example:- Suppose you hold ₹ 2 cr. shares of X Ltd. whose Mkt. Price S.D is 2% per Day.

Assume 252 trading days in a year, determine the maximum loss level over the period of 1 Trading Day & 10 Trading Day with 99% Confidence level.

Solution: Maximum Loss for 1 Day at 99% Confidence level:-

$\Rightarrow$ Z-value $\times$ σ $\times$ Asset Value

$\Rightarrow 2.33 \times 2\% \times 2\text{cr.}$

$\Rightarrow 9.32$ lakhs

Maximum Loss for 10 Trading Days:-

$\Rightarrow 9.32 \text{ lakhs} \times \sqrt{10}$

$\Rightarrow 29.47$ lakhs ✓

OR

Z-value $\times \sigma_{10\,Days} \times$ Asset value

$\Rightarrow 2.33 \times 2\% \times \sqrt{10} \times 2\text{cr.}$

$\Rightarrow$ ₹ 29.47 lakhs ✓

Q.2 Pg. 14.6

Asset Value = ₹ 1 cr.

S.D / Day = 2%

252 Trading Days in a year

99% → 1 Day & 10 Days

Max. Loss

Z-Value$_{1\%}$ = **2.33**

Solⁿ: For 1 Day:-

⇒ Z-Value$_{1\%}$ × S.D × Asset Value

⇒ 2.33 × 0.02 × 1 cr.

⇒ ₹ 4,66,000

For 10 Days :-

$\Rightarrow$ £ 466,000 × $\sqrt{10}$

$\Rightarrow$ £ 14,73,621

⇒ **Application of Correlation in VAR Calculation:-**

Risk aggregation at the top management level is not simple addition, Correlation comes into the picture.

Example:

A firm has 2 Division A & B

Firm has computed the 95% Daily VAR of the 2 Division (i.e. the maximum possible daily loss with a Confidence of 95%)

VAR_A = \$15 million

VAR_B ⇒ \$40 million

If 'r' between the two Division is 0.25

Soln: Cal. VAR of the firm.

$VAR_P = ?$ 2 Asset Model.

$$VAR_P = \sqrt{VAR_A^2 + VAR_B^2 + 2\, VAR_A\, VAR_B\, r_{A,B}}$$

1

$$\Rightarrow \sqrt{15^2 + 40^2 + 2 \times 15 \times 40 \times 0.25}$$

$VAR_P \Rightarrow$ \$ 46.10 million

Note:- If 2 Divisions are perfectly positively Correlated i.e. $r = 1$

$$\boxed{VAR_P = VAR_A + VAR_B}$$

Practically:- $r < 1$, therefore

$$\boxed{VAR_P < VAR_A + VAR_B}$$

This is called Diversification Benefit.

Example:

Stock A = 50cr.

Stock B = 500 cr

Information

	σ
A	10% σ
B	15% σ

$r_{A,B} = \underline{\underline{0.30}}$

Cal. 1 with VAR of the Portfolio at 95% Confidence level.

Solution:- Stock A

Exposure = 50 cr.

At 95% Confidence level = Z-Value = $\underline{\underline{1.65}}$

$$\text{Monthly S.D} = \frac{\text{Annual S.D}}{\sqrt{12}} = \frac{10}{\sqrt{12}}$$

$$\Rightarrow \underline{\underline{2.89}}$$

$$VAR_A = \text{Z-Value} \times \sigma \times \text{Exposure}$$

$$\Rightarrow 1.65 \times 2.89 \times 50\text{cr.}$$

$$\Rightarrow \underline{\underline{2.384 \text{ cr.}}}$$

Stock B

Asset Value = $\underline{\underline{500 \text{ cr.}}}$

Z-Value 95% = 1.65

$$\text{S.D. Monthly} \Rightarrow \frac{15}{\sqrt{12}} \Rightarrow \underline{\underline{4.33\%}}$$

$VAR_B = Z\text{-Value} \times \sigma \times \text{Asset Value}$

$\Rightarrow 1.65 \times 4.33\% \times 500 \text{ cr.}$

$\Rightarrow \underline{\underline{35.72 \text{ cr.}}}$

$$VAR_P = \sqrt{VAR_A^2 + VAR_B^2 + 2\, VAR_A\, VAR_B\, r_{A,B}}$$

$$\Rightarrow \sqrt{(2.384)^2 + (35.72)^2 + 2 \times 2.384 \times 35.72 \times 0.30}$$

$\underline{\underline{VAR_P}} \Rightarrow ₹\ \underline{\underline{36.51 \text{ cr.}}}$

Q.3 Inf.

XYZ = ₹ 200 lakh

ABC = ₹ 200 lakh

Daily S.D (σ) = 1%

$r_{ABC, XYZ} = 0.30$

$Z_{99\%} \Rightarrow 2.33$

VAR_{p} 10 Days = ?

$\sigma_{10\ Days} = 1\% \times \sqrt{10}$

$\Rightarrow 3.1623\%$

$VAR_{ABC} \Rightarrow$ Z-Value$_{1\%}$ × σ × Asset Value

$\Rightarrow 2.33 \times 3.1623\% \times 200$ lakh

$\Rightarrow 14.7363$ lakh

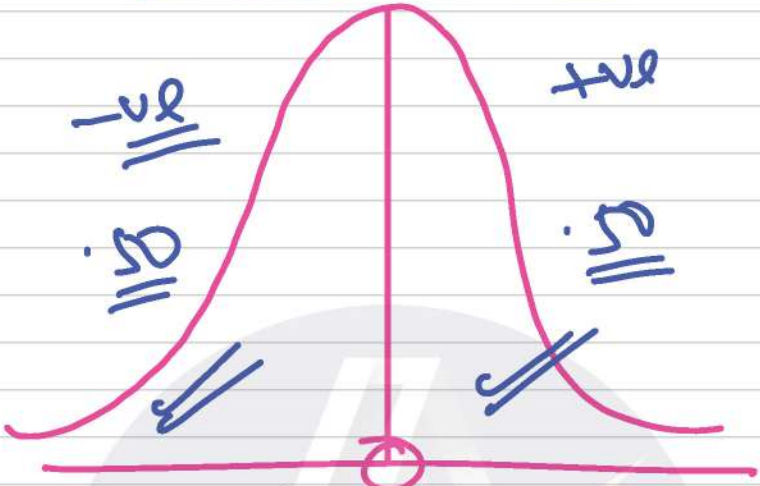
$VAR_{XYZ} = 14.7363$ lakh

$$VAR_P \Rightarrow \sqrt{VAR_{ABC}^2 + VAR_{XYZ}^2 + 2\,VAR_{ABC}\,VAR_{XYZ}\,\gamma_{ABC,XYZ}}$$

$$\Rightarrow \sqrt{14.7363^2 + 14.7363^2 + 2 \times 14.7363 \times 14.7363 \times 0.3}$$

$\Rightarrow$ ₹ 23.7616 lakh

Note:- Normal Distribution:-



Bell Curve | Probability Curve

$$\boxed{Z = \frac{X - \mu}{\sigma}}$$

μ = Mean

σ = S.D

Example:

Daily Income of Worker follows Normal Distribution with Mean ₹1000 & S.D ₹100.

Find the Prob. of Income less than ₹1100

Sol^n

$X = ₹1100$ $\mu = 1000$

$\sigma = 100$

$$Z = \frac{X-\mu}{\sigma} \Rightarrow \frac{1100-1000}{100}$$

$Z \Rightarrow 1$ +ve

Prob. of Income less than ₹1100

$P(X<1100) = P(Z<1)$

$P=1$

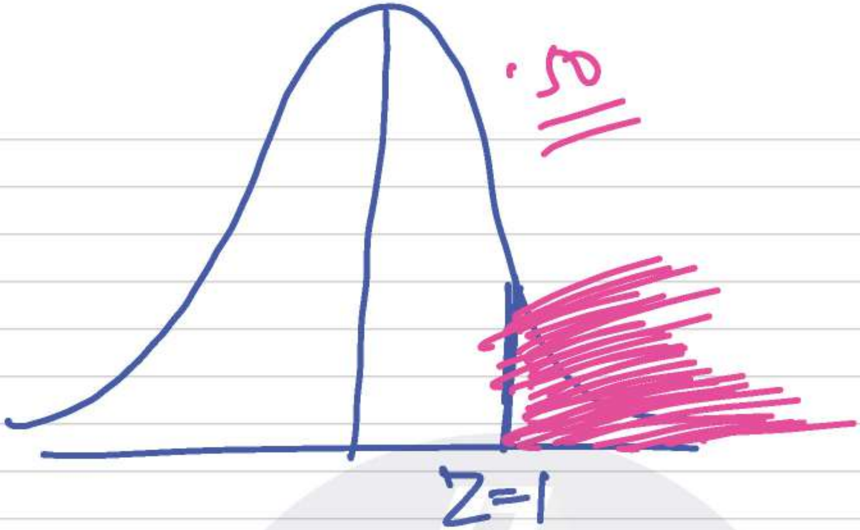
$\Rightarrow .50 + .3413 \Rightarrow 0.8413$

or 84.13%

(ii) More than ₹1100

$Z=1$ $\quad P(X>1100)$

$P(Z>1)$



$P \Rightarrow 0.50 - .3413$

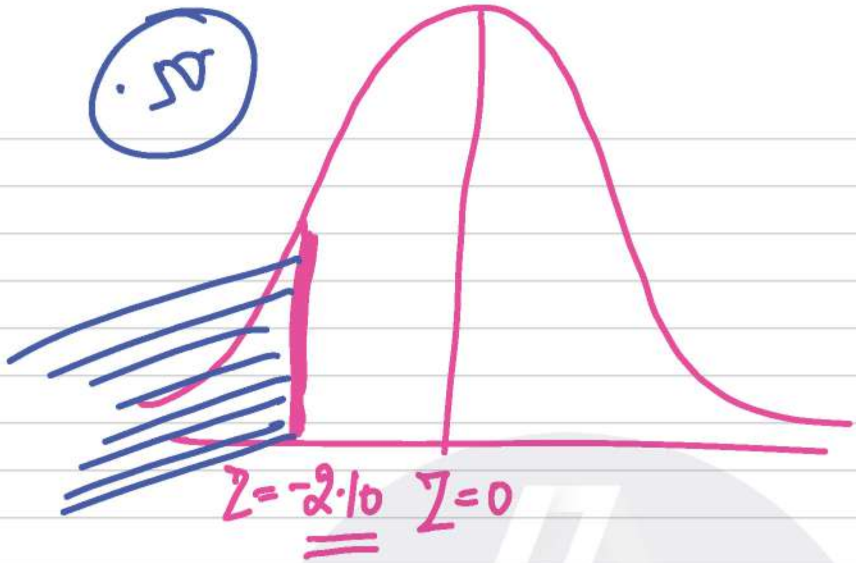
$\Rightarrow .1587$ or 15.87%

(iii) Less than ₹790

$$Z = \frac{790 - 1000}{100} \rightarrow (-)\ 2.10$$

$P(X < 790)$

$P(Z < -2.10)$



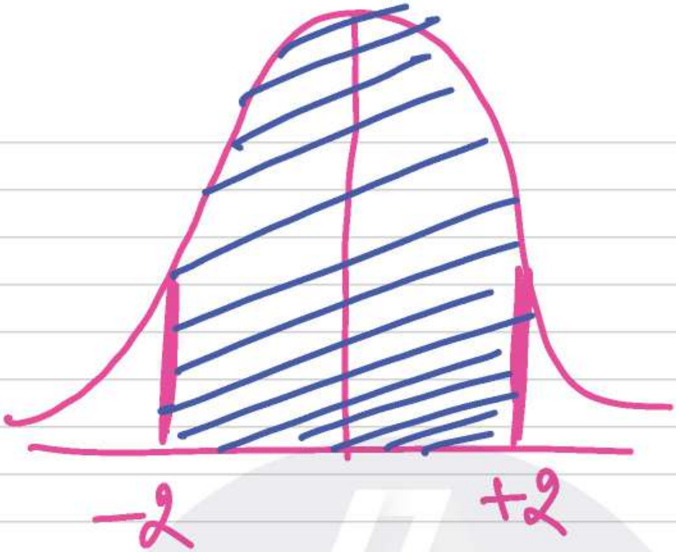
$\Rightarrow .50 - .4821 \Rightarrow 0.0179$

or 1.79%

(iv) **Between 800 to 1200**

$$Z = \frac{800-1000}{100} = -2$$

$$Z = \frac{1200-1000}{100} = 2$$



$Z = 2 \Rightarrow \underline{\underline{.4772}}$

$P\,[800 < X < 1200)$

$\Rightarrow .4772 + .4772$

$\Rightarrow .9544$ i.e. $\underline{\underline{95.44\,\%}}$

Q.5 Imp.

Mean Return = 2 cr.

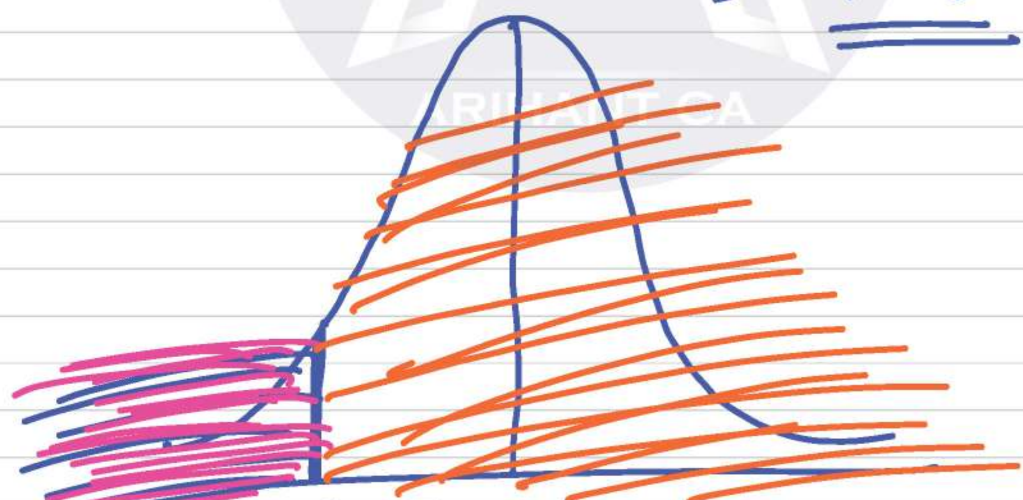
σ = 1.6 cr.

Prob. of loss more than 1 cr

$X = -1$ cr.

$$Z = \frac{X - \mu}{\sigma} \Rightarrow \frac{-1\text{cr.} - 2\text{cr.}}{1.6\text{cr.}}$$

$$\Rightarrow -1.875$$



-1.875

$$Z = \frac{0.4693 + .4699}{2}$$

Prob. ⇒ 0.4696 i.e. 46.96%

Extra Part:

Loss → less than 1 cr.

.50 + .4696 i.e. .9696

i.e. 96.96%

Q.4 V.V. Imp.

TWTF = 4 Days

Minimum Balance = £1000

Max. Possible Investment

where VAR not exceed £699000

$\sigma = 1.5\%$ / Day   99% CL

Solⁿ

Max. Loss for 4 Days at 99%

(7,00,000 − 1000) ⇒ £ 699000

1 Day VAR ⇒ $\frac{699000}{\sqrt{4}}$ ⇒ 349500

$349500 = Z \times \sigma \times \text{Asset Value}$

$349500 = 2.33 \times 1.5 \times x$

$$\boxed{x \Rightarrow ₹100,00,000}$$

Max. Possible Investment = ₹ 100,00,000