# METHODIST COLLEGE OF ENGINEERING & TECHNOLOGY

# HYDERABAD

## DEPARTMENT OF MECHANICAL ENGINEERING


## LECTURE NOTES

## FOR

## Industrial Administration and Financial Management

## X-Chait

$$CL = \bar{\bar{X}}$$

$$UCL = \bar{\bar{X}} + \frac{3\bar{R}}{d_2\sqrt{n}} = \bar{\bar{X}} + A_2\bar{R}$$

$$LCL = \bar{\bar{X}} - \frac{3\bar{R}}{d_2\sqrt{n}} = \bar{\bar{X}} - A_2\bar{R}$$

Note:

In Exam, either '$d_2$' value or '$A_2$' value will be provided for particular '$n$' value

$\bar{X}$ = Arthamatic Mean of $i^{th}$ sample

$$CL = \bar{\bar{X}} = \sum \frac{\bar{X}_i}{K}, \quad i = 1, 2, \ldots k$$

$$\bar{R} = \sum \frac{R_i}{K}; \quad i = 1, 2, 3 \ldots K$$

## For. R-Chart

Central Line $CL = \Sigma \frac{R_i}{K}$

Upper control Limit, $UCL = \bar{R}\left[1 + \frac{3d_3}{d_2}\right] (\text{or}) = \bar{R} D_4$

Lower Control Limit, $LCL = \bar{R}\left[1 - \frac{3d_3}{d_2}\right] (\text{or}) = \bar{R} D_3$

In Exam, either $(D_3 \& D_4)$ or $(d_3, d_2)$ values will be provided.

Q The following data of 10 sample readings, of size = 8 each in the production of a certain component

| Sample no. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 5.4 | 5.1 | 5.4 | 4.9 | 5.2 | 4.7 | 5.1 | 5.0 | 5.0 | 5.2 |
| Range | 0.4 | 0.7 | 0.7 | 0.8 | 0.9 | 0.6 | 0.5 | 0.6 | 0.7 | 0.6 |

Draw the control charts for mean and range, and point out which samples, if any are out of limit.

Sol

$\bar{X}$ - Chart

① $CL = \bar{\bar{X}} = \frac{\sum \bar{X}_i}{K} = \frac{(5.4 + 5.1 + 5.4 \ldots\ldots\ldots + 5.2)}{10} = 5.1$

② $\bar{R} = \frac{\sum R_i}{K} = \frac{(0.4 + 0.7 + 0.7 + 0.8 + \ldots\ldots 0.6)}{10} = 0.65.$

③ $UCL$ = Upper control limit =

$= \bar{\bar{X}} + \frac{3\bar{R}}{d_2\sqrt{n}} =$

$= 5.1 + \frac{(3 * 0.65)}{2.847\sqrt{8}} = 5.342$

④ Lower Control Limit (LCL)

$LCL = \bar{\bar{X}} - \frac{3\bar{R}}{d_2\sqrt{n}}$

$= 5.1 - \frac{(3 \times 0.65)}{2.847\sqrt{8}} = 4.857$

Note:
Here, $d_2$ value will be given for the given sample size.
Here, $n = 8$ for that $d_2 = 2.847$.

If $d_2$ value is not given then $A_2$ value will be given. In that case, the formula will be

$UCL = \bar{\bar{X}} + A_2\bar{R}$

&

$LCL = \bar{\bar{X}} - A_2\bar{R}$

## $\bar{R}$ - Chart

① $CL = \bar{R} = 0.65$

② $UCL = \bar{R} \times D_4 = 0.65 \times 1.864 = 1.2116$

③ $LCL = \bar{R} \times D_3 = 0.65 \times 0.136 = 0.0884$

Note

$D_4$ & $D_3$ values will be given in Exam,

For $n=8$
$D_4 = 1.864$
$D_3 = 0.136$

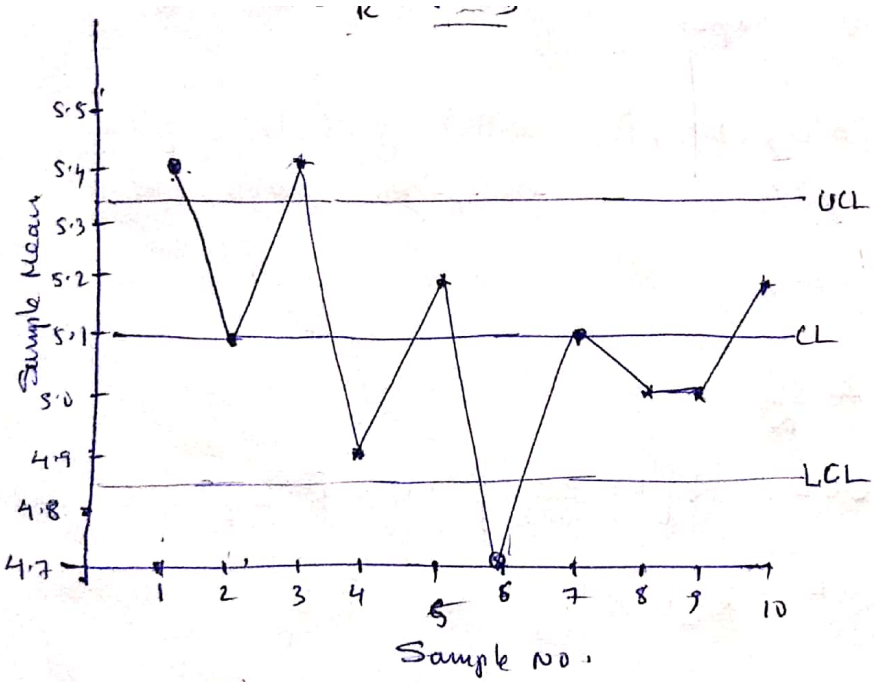
If, $D_3$ & $D_4$ values are not given,
instead, $d_2$ & $d_3$ values will be given.
In that case the formula would be

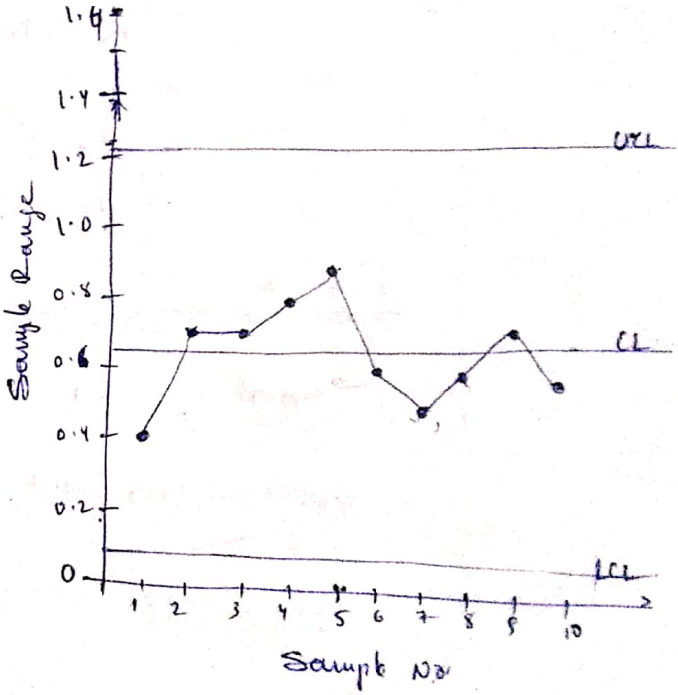
$$CL = \bar{R}$$

$$UCL = \bar{R}\left[1 + 3\frac{d_3}{d_2}\right]$$

$$LCL = \bar{R}\left[1 - 3\frac{d_3}{d_2}\right]$$

Now draw the $\bar{X}$ & R Charts as shown below.




Mean ($\bar{X}$) chart

Observation :- Samples 1, 3, 6 in mean chart are beyond control limits.

# Minimization Problem (Graphical Method)

$Z = 1000x_1 + 800x_2$ ← Minimize

Subjected to $6x_1 + 2x_2 \geq 12$

$4x_1 + 12x_2 \geq 24$.

~~$x_1 \geq 0, x_2 \geq 0$~~.

$2x_1 + 2x_2 \geq 8$

$x_1 \geq 0, x_2 \geq 0$

**Sol:**

Objective function ⇒ $Z = 1000x_1 + 800x_2$

Constraints:

$6x_1 + 2x_2 \geq 12$
$4x_1 + 12x_2 \geq 24$
$2x_1 + 2x_2 \geq 8$

} Re write the Constrain inequalities as equalilites and solve to obtain the intrecepts.

∴ $6x_1 + 2x_2 = 12$

Set $x_1 = 0$, ⇒ solve for $x_2$

⇒ $6(0) + 2x_2 = 12$

⇒ $x_2 = 6$

Set $x_2 = 0$ & solve for $x_1$

⇒ $6x_1 + 2(0) = 12$

⇒ $x_1 = 2$

∴ The point of intercepts are $(0,6)$ & $(2,0)$ for line $6x_1 + 2x_2 = 12$

$4x_1 + 12x_2 = 24$

Set $x_1 = 0$, ⇒ $x_2 = 2$ - $(0,2)$

Set $x_2 = 0$ ⇒ $x_1 = 6$ $(6,0)$

∴ point of intercepts are $(0,2)$ & $(6,0)$ for $4x_1 + 12x_2 = 24$

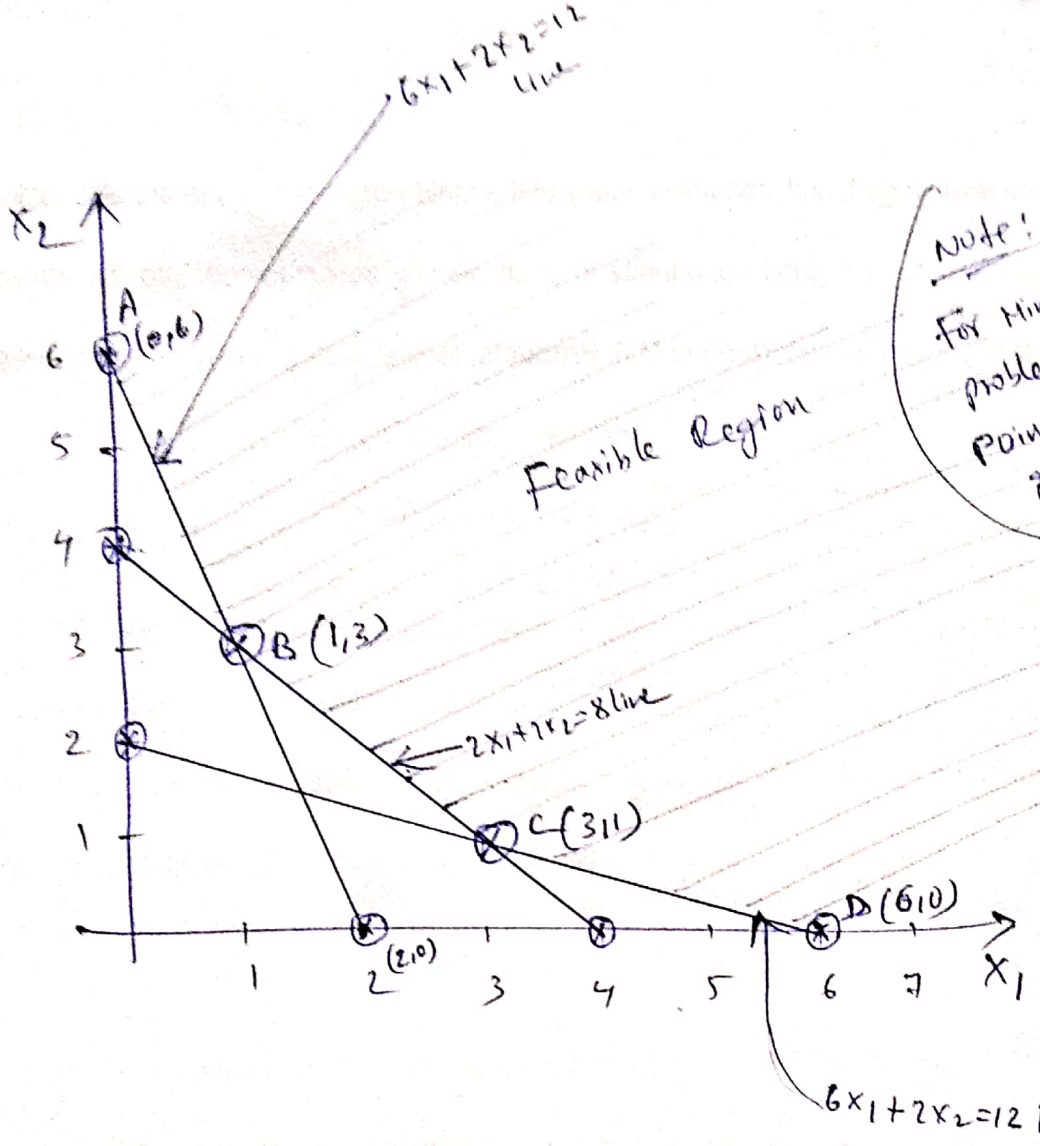
$2x_1 + 2x_2 = 8$

Set $x_1 = 0$, ⇒ $x_2 = 4$ ∴ point = $(0,4)$

Set $x_2 = 0$

⇒ $x_1 = 2$ ⇒ Point = $(4,0)$

Now draw the Graph as below




Note:-
For minimization problem select the intersection points away from the origin.

Value of Z at these extream point. ~~A B C D~~ A(0,6), B(1,3), C(3,1) & D(6,0)

$Z = 1000x_1 + 800x_2$

$Z_A = 1000(0) + 800(6) = 4800$

$Z_B = 1000(1) + 800(3) = 3400$

$Z_C = 1000(3) + 800(1) = 3800$

$Z_D = 1000(6) + 800(0) = 6000$

The least value of Z occurs at ~~B C D~~ B(1,3) is $Z = 3400$