1) No. of samples = 19

$\bar{p} = \frac{x}{n}$ $\quad UCL_p = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$LCL_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

Total no. of screws inspected = 14091

defective pieces = 1030

$$\bar{p} = \frac{1030}{14091} = 0.07309$$

$$UCL_p = 0.07309 + 3\sqrt{\frac{0.07309(1-0.07309)}{19}}$$

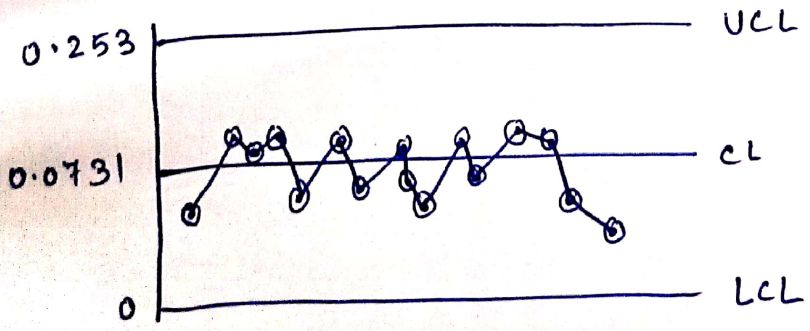
$$= 0.07309 + 3\sqrt{\frac{0.067631}{19}} = 0.253$$

$$LCL_p = 0.07309 - 3\sqrt{\frac{0.07309(1-0.07309)}{19}}$$

$$= -0.107 \longrightarrow 0$$

$$\bar{X} \text{ factorial (defects)} = \frac{0.066 + 0.109 + \cdots + 0.038}{19}$$

$$\therefore CL \simeq \bar{X} = 0.0731$$



2) S.D of sample mean

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \left(\frac{0.2}{\sqrt{4}}\right) = 0.1$$

centerline ($\bar{x}$-double bar)

$$\bar{\bar{x}} = \frac{15.15 + 15.825 + 15.65}{3} = 15.54$$

$$UCL_{\bar{x}} = \bar{\bar{x}} + Z\sigma_{\bar{x}} = 15.54 + 3(0.1) = 15.84$$

$$LCL_{\bar{x}} = \bar{\bar{x}} + Z\sigma_{\bar{x}} = 15.92 - 3(0.1) = 15.62$$

$$\bar{R} = \frac{0.9 + 1.4 + 1.2}{3} = 1.166$$

Center line: $CL = \bar{\bar{x}} = 15.54$

$$UCL_{\bar{x}} = \bar{\bar{x}} + A_2\bar{R} = 15.54 + (0.73) \times 1.166 = 16.39$$

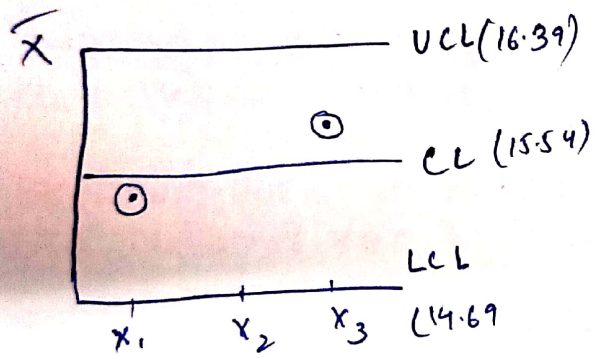
$$LCL_{\bar{x}} = \bar{\bar{x}} + A_2\bar{R} = 15.54 - (0.73) \times 1.166 = 14.68$$

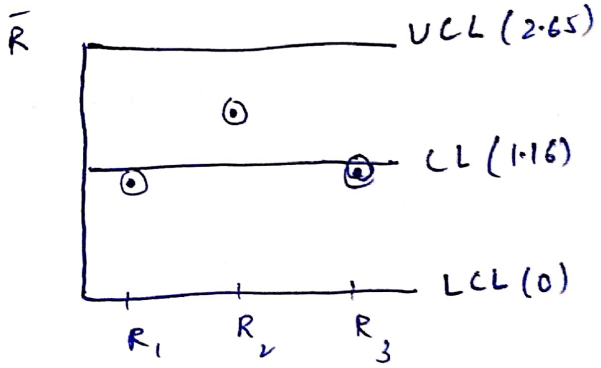
R chart :-

$$CL = \bar{R} = \frac{0.9 + 1.4 + 1.2}{3} = 1.166$$

$$UCL = D_4\bar{R} = 2.28 \times 1.166 = 2.65$$

$$LCL = D_3\bar{R} = 0 \times 1.166 = 0$$





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