

Types of control charts

Variables

-- product characteristics that can be measured

range (R-chart) - measures spread of the process

mean (\bar{x} -chart) - Average chart (assumes central tendency)

Attributes

- Product characteristics that can be evaluated

p-chart

c-chart

Ex

$$\bar{x} = \frac{x_1 + x_2 + \dots + x_n}{n}$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

of sample means

and n = no. of observation w/in each sample

For \bar{x} -chart

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

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

$$CL = \bar{\bar{x}}$$

R-chart

$$UCL = D_4 \bar{R}$$

$$LCL = D_3 \bar{R}$$

$$CL = \bar{R}$$

Control charts for variable data

Sample	nick ring diameter (cm)					\bar{x}	R
	1	2	3	4	5		
1	5.02	5.01	4.94	4.99	4.96	4.984	0.08
2	5.01	5.03	5.07	4.95	4.96	4.972	0.12
3	4.99	5.00	4.93	4.92	4.99	4.966	0.08
4	5.03	4.91	5.01	4.98	4.89	4.964	0.14
5	4.95	4.92	5.03	5.05	5.01	4.992	0.13
6	4.97	5.06	5.06	4.96	5.03	5.016	0.1
7	5.05	5.01	5.10	4.96	4.99	5.022	0.14
8	5.09	5.10	5.00	4.99	5.08	5.052	0.11
9	5.14	5.10	4.99	5.08	5.09	5.08	0.15
10	5.01	4.98	5.08	5.07	4.99	5.026	0.1

$$\bar{\bar{x}} = 5.0056$$

$$\bar{R} = 0.115$$

$$A_2 = 0.577 \quad D_4 = 2.114, \quad D_3 = 0$$

For R-chart

$$UCL = D_4 \bar{R} = 2.114 \times 0.115 = 0.24311$$

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

$$CL = 0.115$$

For \bar{X} chart

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

$$= 5.01066 + 0.577 \times 0.115$$

$$= 5.0769$$

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

$$= 4.9402$$

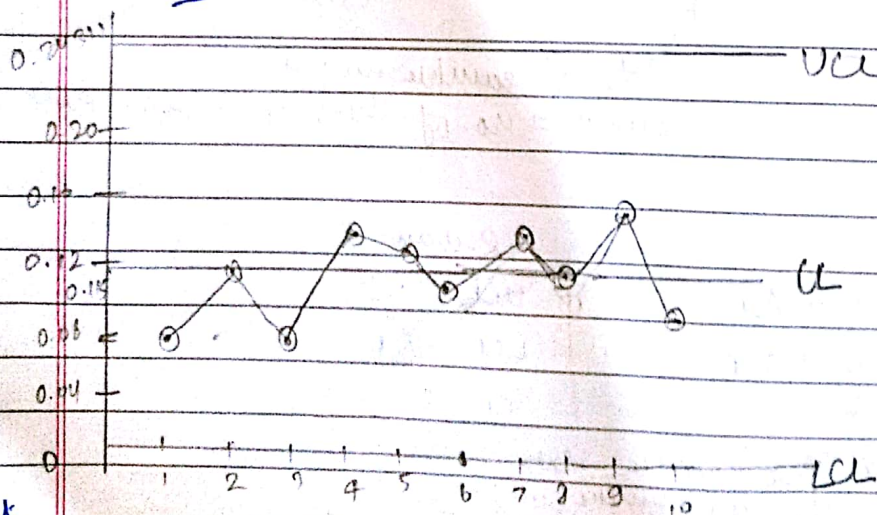
$$CL = 5.01066$$

Note:

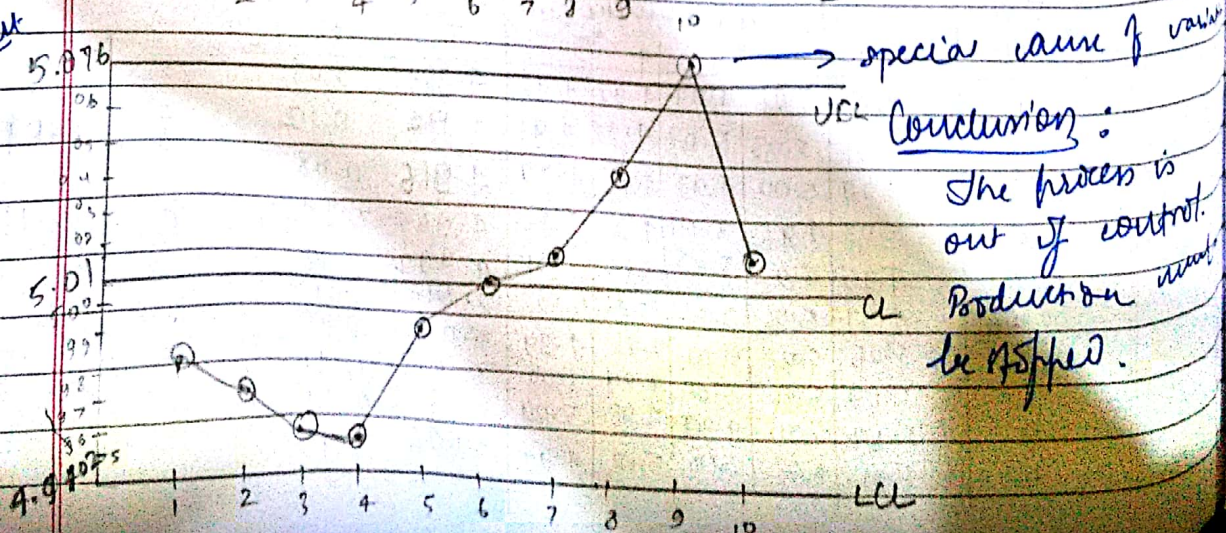
If $LCL < 0$,

then $LCL = 0$

R-chart



\bar{X} -chart



Conclusion:

The process is out of control.

Production must be stopped.