ME EN 2550 Ryan Mills Homework 9

1. $\bar{x}$ chart

$\bar{\bar{x}} = 14.51$ $r = 0.344$ $s = 0.1456$

UCL: $CL + 3\left(\frac{s}{.94\sqrt{25}}\right) = 14.603$ $c_4 = .94$

CL $= 14.51$

LCL: $CL - 3\left(\frac{s}{.94\sqrt{25}}\right) = 14.417$

s chart

UCL: $s + 3\frac{s}{c_4}\sqrt{1-c_4^2} = 0.3041$

CL: 0.1456

LCL: $s - 3\frac{s}{c_4}\sqrt{1-c_4^2} = -0.0129$ O

2. UCL $= 48.75$ $\sigma = 2.25$ Find

LCL $= 42.71$

$\mu + \frac{3\sigma}{\sqrt{n}} - \mu - \frac{3\sigma}{\sqrt{n}}$ UCL − LCL $\frac{6\sigma}{\sqrt{n}} = 6.04$ $6\sigma = 2.25$

$n = 5$

3. UCL $= 48.75$ $n = 4$ $\mu + 3\sigma_{\bar{x}} = 48.75$

LCL $= 40.55$ $\mu - 3\sigma_{\bar{x}} = 40.55$

$\sigma = 4.1$ $6\sigma_{\bar{x}} = 8.2$

$\sigma_{\bar{x}} = \frac{s}{\sqrt{n}c_4} = 2.73$ $\sigma_{\bar{x}} = 1.367$

7 100 ± 20 $\sigma = 6$

a) $\mu = 100$

Natural limits

$100 \pm 3\sigma$

100 ± 18

$C_p = \frac{120 - 80}{6(6)} = \frac{40}{36} = 1.111$

$C_{pk} = \min\left[\frac{20}{3(6)}, \frac{20}{3(6)}\right] = 1.111$

$2 \cdot P\left(Z > \frac{20}{6}\right) = .08$

b) Natural limits

106 ± 18

$\mu = 106$

106 ± 20 $126 - 100$

$106 - 86$

$C_p = \frac{126 - 86}{6(6)} = 1.111$

$C_{pk} = \min\left[\frac{26}{3(6)}, \frac{14}{3(6)}\right] = .7778$

$P\left(\frac{\bar{X}}{2} < \frac{LSL}{-2.33}\right) + P\left(\frac{\bar{X}}{2} > \frac{USL}{4.33}\right) = 0.0094 + 0 = 0.0048$

8. a) $6\sigma = 0.667(USL - LSL)$

$3\sigma = .667(USL - \mu) = .667(\mu - LSL)$

$4.5\sigma = USL - \mu = \mu - LSL$

$C_p = C_{pk} = \min\left[\frac{4.5\sigma}{3\sigma}, \frac{4.5\sigma}{3\sigma}\right] = 1.5$

b) $2 \cdot P(\bar{X} > USL) = 2P\left(Z > \frac{4.5\sigma}{\sigma}\right) \approx 0$

9. 14.5 ± 0.50

$\mu = 14.510$ $\sigma = \frac{mr}{d} = \frac{.344}{2.326} = .148$ ← 8.6/25

$\frac{14 - 14.51}{.148} = -3.44$

$\frac{15 - 14.51}{.148} = 3.31$

$P(\bar{X} < LSL) = P(Z < -3.44) = .00028$

$P(\bar{X} > USL) = P(Z > 3.31) = .00047$

Nonconforming % = 0.075%

b) $C_p = \frac{15 - 14}{6(.148)} = 1.13 = C_p$ $C_{pk} = \min\left[\frac{15 - 14.51}{3(.148)}, \frac{14.51 - 14}{3(.148)}\right]$

$C_{pk} = 1.104$

10. 16 ± 5

$\sigma = \frac{2.25}{1.693} = 1.329$ ← $\frac{21.2-7.7}{60}$

d_2

$\bar{x} = 15.09$

$P(\bar{X} > 15) + P(x < 5) = P\left(\frac{15-15.09}{1.693}\right) + P\left(\frac{5-15.09}{1.693}\right)$

$= 0.5120 + 0.0 = .5120$

$C_p = \frac{15-5}{6(1.693)} = 0.985$, Process capability is not good.

ME EN 2550

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Homework 9

1) $\bar{X}$ control limits:

   UCL: 14.603

   CL: 14.51

   LCL 14.417

   S control limits:

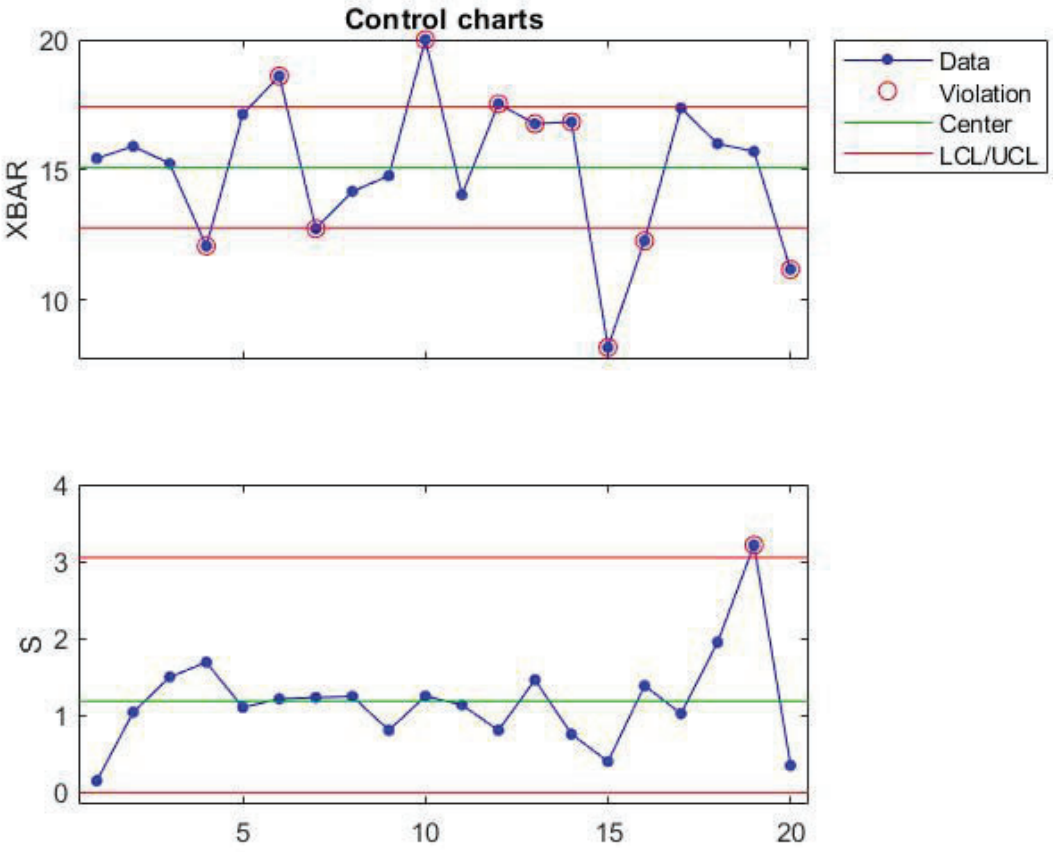
   UCL: 0.3041

   CL: 0.1456

   LCL: 0.0

2) n = 5.0

3) σ = 2.73



4)

$\bar{X}$ control limits:
UCL: 17.4151

CL: 15.0933

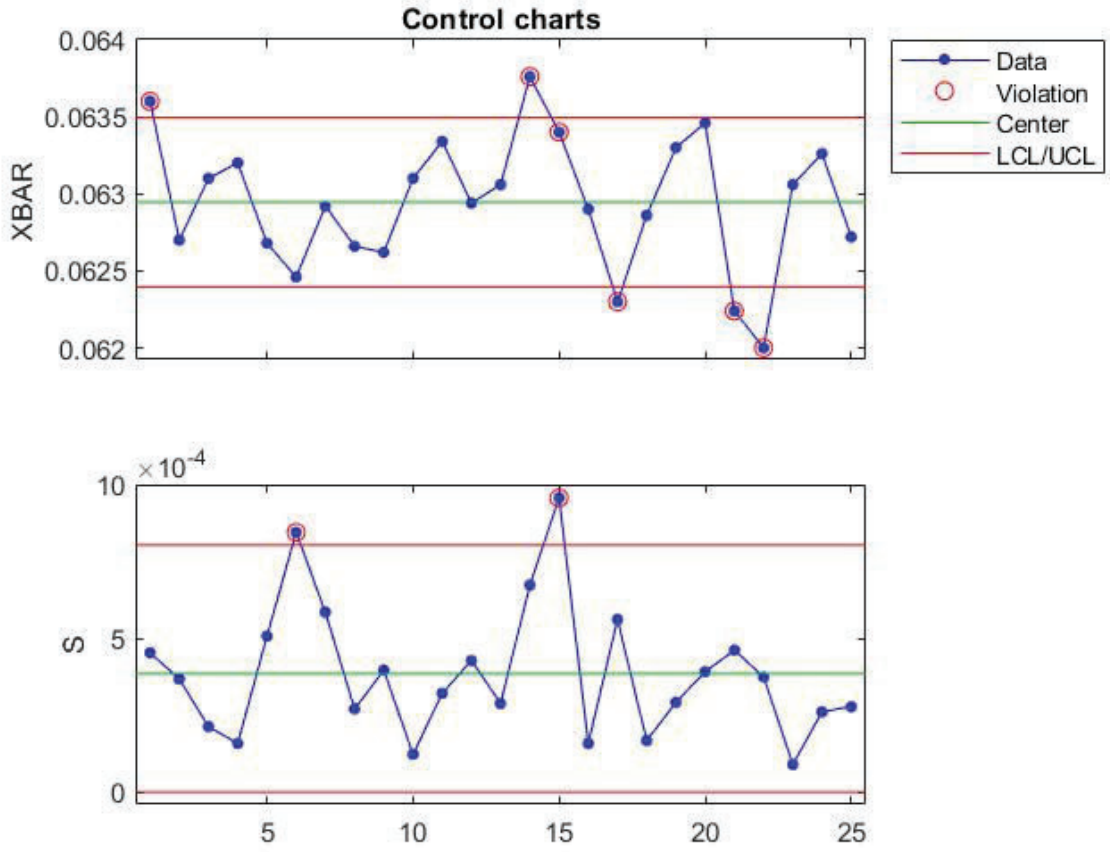
LCL 12.7715

S control limits:
UCL: 3.0509

CL: 1.1880

LCL: 0.0

Out of control points: 4, 6, 7, 12, 15, 16, 19, and 20



5)

$\bar{X}$ control limits:
UCL: 0.0635

CL: 0.0629

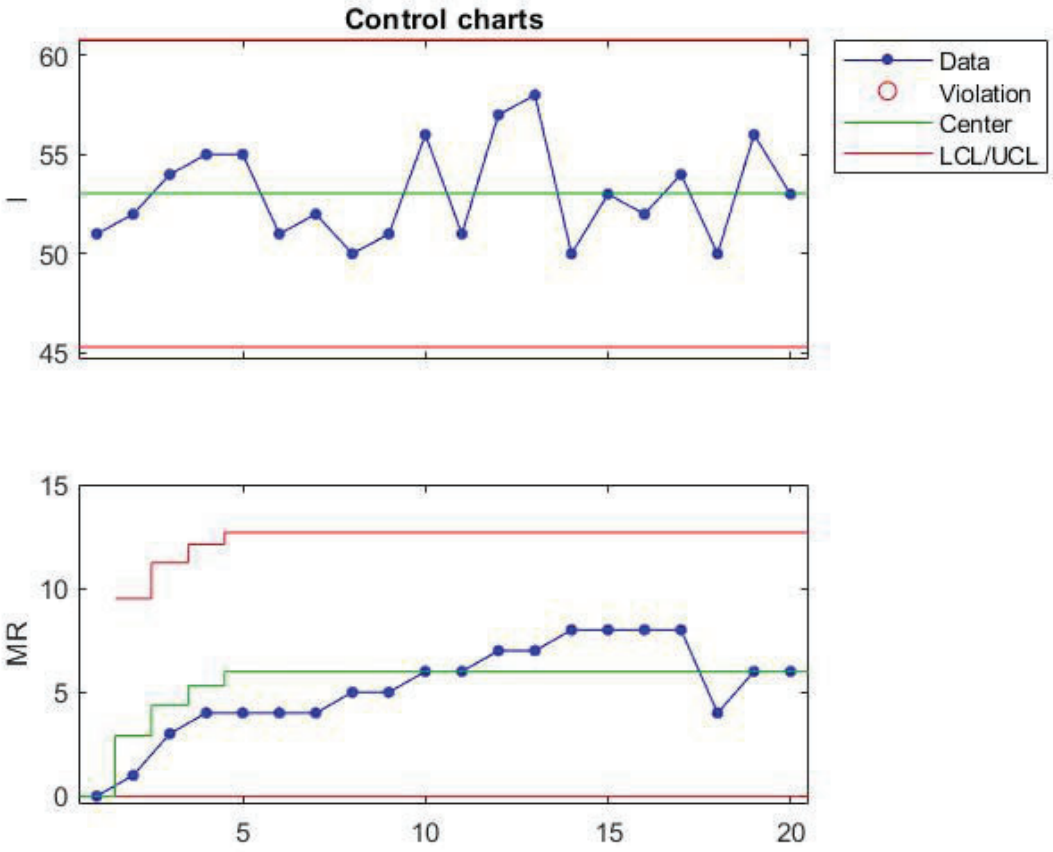
LCL: 0.0624

S control limits:
UCL: 0.0008034

CL: 0.0003846

LCL: 0.0

Out of control points: 1, 6, 14, 15, 17, 21, 22



6)

I control limits:
UCL: 60.7888

CL: 53.0500

LCL: 45.3112

MR control limits:

UCL: 12.6870 (9.5082)

CL: 6.00 (2.9108)

LCL: 0.0

This process appears to be in control.

mu = 53.05

sigma = 2.613

Code:

```
%HW 9
p4data = xlsread('HW9Data.xlsx', 'Problem4');
p5data = xlsread('HW9Data.xlsx', 'Problem5');
p6data = xlsread('HW9Data.xlsx', 'Problem6');
fprintf('Problem 4:')
data = p4data(:,2:4);
[st4 ,plotdata4] = controlchart(data,'charttype',{'xbar' 's'}, 'rules', 'we2');
plotdata4.lcl
plotdata4.cl
plotdata4.ucl
R4 = controlrules('we2',st4.mean,st4.mu,st4.sigma./sqrt(st4.n));


figure();
fprintf('Problem 5:')
data = p5data(:,2:6);
[st5, plotdata5] = controlchart(data,'charttype',{'xbar' 's'}, 'rules', 'we2');
plotdata5.lcl
plotdata5.cl
plotdata5.ucl
R5 = controlrules('we2',st5.mean,st5.mu,st5.sigma./sqrt(st5.n));
```

```
figure();
fprintf('Problem 6:')
[st6, plotdata6] = controlchart(p6data(:,2),'charttype',{'i', 'mr'}, 'rules', 'we2');
plotdata6.lcl
plotdata6.cl
plotdata6.ucl
```