INDU372/4T - Quality Control and Reliability (Credits: 3.0)

Formula Sheet, Final Exam, April 2013

1. Control charts

$\overline{X}$ and R Control Charts

UCL= $\overline{\overline{x}} + A_2\overline{R}$, CL = $\overline{\overline{x}}$ (Center Line), LCL= $\overline{\overline{x}} - A_2\overline{R}$;

UCL= $D_4\overline{R}$, CL = $\overline{R}$, LCL= $D_3\overline{R}$; $\hat{\sigma} = \overline{R}/d_2$

$C_p = \frac{USL - LSL}{6\sigma}$, $C_{\hat{p}} = \frac{USL - LSL}{6\hat{\sigma}}$, P = (1/Cp)*100%

Changing sample size:

$\overline{x}$ chart: UCL= $\overline{\overline{x}} + A_2\left[\frac{d_2(new)}{d_2(old)}\right]\overline{R}_{old}$, CL= $\overline{\overline{x}}$ (Center Line), LCL= $\overline{\overline{x}} - A_2\left[\frac{d_2(new)}{d_2(old)}\right]\overline{R}_{old}$

R chart: UCL= $D_4\left[\frac{d_2(new)}{d_2(old)}\right]\overline{R}_{old}$, CL= $\overline{R}_{new} = \left[\frac{d_2(new)}{d_2(old)}\right]\overline{R}_{old}$, LCL= $\max\left\{0, D_3\left[\frac{d_2(new)}{d_2(old)}\right]\overline{R}_{old}\right\}$

s chart: $s = \sqrt{\left(\sum_{i=1}^{n}(x_i - \overline{x})^2\right) \Big/ (n-1)}$. Standard deviation given: UCL= $B_6\sigma$, CL= $C_4\sigma$, LCL= $B_5\sigma$

Standard deviation not given: UCL= $B_4\overline{s}$, CL= $\overline{s}$, LCL= $B_3\overline{s}$

UCL= $\overline{\overline{x}} + A_3\overline{s}$, CL= $\overline{\overline{x}}$, LCL= $\overline{\overline{x}} - A_3\overline{s}$

Control charts for attributes:

p Chart: UCL= $p + 3\sqrt{p(1-p)/n}$, CL = p , LCL= $p - 3\sqrt{p(1-p)/n}$

np Chart: UCL= $np + 3\sqrt{np(1-p)}$, CL = np , LCL= $np - 3\sqrt{np(1-p)}$

Use $\overline{p}$ if standard is not given

c Chart: UCL= $c + 3\sqrt{c}$, CL = c , LCL= $c - 3\sqrt{c}$.

u Chart: $u_i = x_i/n$, $\overline{u} = \sum x_i \big/ n \times m$, UCL= $\overline{u} + 3\sqrt{\overline{u}/n}$, CL = $\overline{u}$, LCL= $\overline{u} - 3\sqrt{\overline{u}/n}$

2. Acceptance sampling

$$1 - \alpha = \sum_{d=0}^{c} \frac{n!}{d!(n-d)!} p_1^d (1-p_1)^{n-d}$$

$$\beta = \sum_{d=0}^{c} \frac{n!}{d!(n-d)!} p_2^d (1-p_2)^{n-d}$$

$AOQ = \frac{P_a p(N-n)}{N}$ or $AOQ = P_a p$

3. Reliability

Exponential: $f(t) = \lambda e^{-\lambda t}$. Normal: $f(t) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{t-\mu}{\sigma}\right)^2}$

Weibull: $f(t) = \frac{\beta}{\alpha^\beta} t^{\beta-1} e^{-\left(\frac{t}{\alpha}\right)^\beta}$, $R(t) = e^{-\left(\frac{t}{\alpha}\right)^\beta}$

$\frac{d \ln x}{dx} = 1/x$