Formulas for STA 309 Final Exam

$$\begin{cases} \text{UCL} &= \overline{\overline{x}} + z_{\alpha/2} \cdot \frac{\overline{R}/d_2}{\sqrt{n}} \\ \text{CL} &= \overline{\overline{x}} \\ \text{LCL} &= \overline{\overline{x}} - z_{\alpha/2} \cdot \frac{\overline{R}/d_2}{\sqrt{n}} \end{cases}$$

$$\begin{cases} \text{UCL} &= \overline{\overline{x}} + z_{\alpha/2} \cdot \frac{\overline{s}/c_4}{\sqrt{n}} \\ \text{CL} &= \overline{\overline{x}} \\ \text{LCL} &= \overline{\overline{x}} - z_{\alpha/2} \cdot \frac{\overline{s}/c_4}{\sqrt{n}} \end{cases}$$

$$\begin{cases} \text{UCL} &= \overline{x} + z_{\alpha/2} \cdot \frac{\overline{\text{MR}}}{d_2} \\ \text{CL} &= \overline{x} \\ \text{LCL} &= \overline{x} - z_{\alpha/2} \cdot \frac{\overline{\text{MR}}}{d_2} \end{cases}$$

$$\begin{cases} \text{UCL} &= \overline{p} + z_{\alpha/2} \cdot \sqrt{\frac{\overline{p}(1-\overline{p})}{n}} \\ \text{CL} &= \overline{p} \\ \text{LCL} &= \max\left(\overline{p} - z_{\alpha/2} \cdot \sqrt{\frac{\overline{p}(1-\overline{p})}{n}}, 0\right) \end{cases}$$

$$\begin{cases} \text{UCL} &= \overline{c} + L \cdot \sqrt{\overline{c}} \\ \text{CL} &= \overline{c} \\ \text{LCL} &= \max\left(\overline{c} - L \cdot \sqrt{\overline{c}}, 0\right) \end{cases}$$

$$\begin{cases} & \textbf{Cumulative sums:} \\ C_i &= \sum_{j=1}^{i} (\overline{x}_j - \mu_0) \\ C_i^+ &= \max\left[0, X_i - (\mu_0 + K) + C_{i-1}^+\right] \\ C_i^- &= \max\left[0, (\mu_0 - K) - X_i + C_{i-1}^-\right] \end{cases}$$

$$\begin{cases} \text{UCL} &= \mu_0 + L \cdot \sigma \cdot \sqrt{\frac{\lambda}{2-\lambda}} \\ \text{CL} &= \mu_0 \\ \text{LCL} &= \mu_0 - L \cdot \sigma \cdot \sqrt{\frac{\lambda}{2-\lambda}} \end{cases}$$

$$\begin{cases} \text{UCL} &= \overline{R} + z_{\alpha/2} \cdot d_3 \cdot \frac{\overline{R}}{d_2} \\ \text{CL} &= \overline{R} \\ \text{LCL} &= \overline{R} - z_{\alpha/2} \cdot d_3 \cdot \frac{\overline{R}}{d_2} \end{cases}$$

$$\begin{cases} \text{UCL} &= \overline{s} + z_{\alpha/2} \cdot \frac{\overline{s}}{c_4} \cdot \sqrt{1 - c_4^2} \\ \text{CL} &= \overline{s} \\ \text{LCL} &= \overline{s} - z_{\alpha/2} \cdot \frac{\overline{s}}{c_4} \cdot \sqrt{1 - c_4^2} \end{cases}$$

$$\begin{cases} \text{UCL} &= \overline{\text{MR}} + z_{\alpha/2} \cdot d_3 \cdot \frac{\overline{\text{MR}}}{d_2} \\ \text{CL} &= \overline{\text{MR}} \\ \text{LCL} &= \overline{\text{MR}} - z_{\alpha/2} \cdot d_3 \cdot \frac{\overline{\text{MR}}}{d_2} \end{cases}$$

$$\begin{cases} \text{UCL} &= n\overline{p} + z_{\alpha/2} \cdot \sqrt{n\overline{p}(1-\overline{p})} \\ \text{CL} &= n\overline{p} \\ \text{LCL} &= \max\left(n\overline{p} - z_{\alpha/2} \cdot \sqrt{n\overline{p}(1-\overline{p})}, 0\right) \end{cases}$$

$$\begin{cases} \text{UCL} &= \overline{u} + L \cdot \sqrt{\frac{\overline{u}}{n}} \\ \text{CL} &= \overline{u} \\ \text{LCL} &= \max\left(\overline{u} - L \cdot \sqrt{\frac{\overline{u}}{n}}, 0\right) \end{cases}$$

$$\widehat{\mu} = \begin{cases} \textbf{New process mean:} & \\ \mu_0 + K + \dfrac{C_i^+}{N^+} & \text{if } C_i^+ > H \\ \mu_0 - K - \dfrac{C_i^-}{N^-} & \text{if } C_i^- > H. \end{cases}$$

$$\begin{cases} \text{UCL} &= \mu_0 + L \cdot \frac{\sigma}{\sqrt{w}} \\ \text{CL} &= \mu_0 \\ \text{LCL} &= \mu_0 - L \cdot \frac{\sigma}{\sqrt{w}} \end{cases}$$

APPENDIX VI

Factors for Constructing Variables Control Charts

	Chart for Averages					Chart for Standard Deviations						Chart for Ranges				
	Factors for Control Limits			Factors for Center Line		Factors for Control Limits				Factors for Center Line		Factors for Control Limits				
Observations in Sample, n	A	A_2	A_3	c_4	$1/c_4$	B_3	B_4	B_5	B_6	d_2	$1/d_2$	d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	1.2533	0	3.267	0	2.606	1.128	0.8865	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	1.1284	0	2.568	0	2.276	1.693	0.5907	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	1.0854	0	2.266	0	2.088	2.059	0.4857	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	1.0638	0	2.089	0	1.964	2.326	0.4299	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	1.0510	0.030	1.970	0.029	1.874	2.534	0.3946	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	1.0423	0.118	1.882	0.113	1.806	2.704	0.3698	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	1.0363	0.185	1.815	0.179	1.751	2.847	0.3512	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	1.0317	0.239	1.761	0.232	1.707	2.970	0.3367	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	1.0281	0.284	1.716	0.276	1.669	3.078	0.3249	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	1.0252	0.321	1.679	0.313	1.637	3.173	0.3152	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	1.0229	0.354	1.646	0.346	1.610	3.258	0.3069	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	1.0210	0.382	1.618	0.374	1.585	3.336	0.2998	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	1.0194	0.406	1.594	0.399	1.563	3.407	0.2935	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	1.0180	0.428	1.572	0.421	1.544	3.472	0.2880	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	1.0168	0.448	1.552	0.440	1.526	3.532	0.2831	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	1.0157	0.466	1.534	0.458	1.511	3.588	0.2787	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	1.0148	0.482	1.518	0.475	1.496	3.640	0.2747	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	1.0140	0.497	1.503	0.490	1.483	3.689	0.2711	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	1.0133	0.510	1.490	0.504	1.470	3.735	0.2677	0.729	1.549	5.921	0.415	1.585
21	0.655	0.173	0.663	0.9876	1.0126	0.523	1.477	0.516	1.459	3.778	0.2647	0.724	1.605	5.951	0.425	1.575
22	0.640	0.167	0.647	0.9882	1.0119	0.534	1.466	0.528	1.448	3.819	0.2618	0.720	1.659	5.979	0.434	1.566
23	0.626	0.162	0.633	0.9887	1.0114	0.545	1.455	0.539	1.438	3.858	0.2592	0.716	1.710	6.006	0.443	1.557
24	0.612	0.157	0.619	0.9892	1.0109	0.555	1.445	0.549	1.429	3.895	0.2567	0.712	1.759	6.031	0.451	1.548
25	0.600	0.153	0.606	0.9896	1.0105	0.565	1.435	0.559	1.420	3.931	0.2544	0.708	1.806	6.056	0.459	1.541

For $n > 25$.

$$A = \frac{3}{\sqrt{n}} \quad A_3 = \frac{3}{c_4\sqrt{n}} \quad c_4 \cong \frac{4(n-1)}{4n-3}$$

$$B_3 = 1 - \frac{3}{c_4\sqrt{2(n-1)}} \quad B_4 = 1 + \frac{3}{c_4\sqrt{2(n-1)}}$$

$$B_5 = c_4 - \frac{3}{\sqrt{2(n-1)}} \quad B_6 = c_4 + \frac{3}{\sqrt{2(n-1)}}$$