Homework # 9 – Control Charts and Process Capability

Problem 1) (5 pts) Twenty-five samples of size 5 are drawn from a process at one-hour intervals, and the following data are obtained:

$$\sum_{i=1}^{25} \bar{x}_i = 362.75 \qquad \sum_{i=1}^{25} r_i = 8.60 \qquad \sum_{i=1}^{25} s_i = 3.64$$

Calculate trial control limits for $\bar{X}$ and S charts.

Problem 2) (5 pts) An $\bar{X}$ control chart with three-sigma control limits has UCL = 48.75 and LCL = 42.71. Suppose that the process standard deviation is $\sigma = 2.25$. What subgroup size was used for the chart?

Problem 3) (5 pts) An $\bar{X}$ control chart with 3-sigma control limits and subgroup size $n = 4$ has control limits UCL = 48.75 and LCL = 40.55. Estimate the process standard deviation.

Problem 4) (10 pts) The pull strength of a wire-bonded lead for an integrated circuit is monitored. The data spreadsheet for this assignment provides data for 20 samples each of size 3.

(a) Use all the data to determine trial control limits for $\bar{X}$ and S charts, construct the control limits, and plot the data.

(b) Use the control limits from part (a) to identify out-of-control points. If necessary, revise your control limits assuming that any samples that plot outside of the control limits can be eliminated.

Problem 5) (10 pts) The thickness of a metal part is an important quality parameter. Data on thickness (in inches) are given in the data spreadsheet for this assignment, for 25 samples of five parts each.

(a) Using all the data, find trial control limits for $\bar{X}$ and S charts, construct the chart, and plot the data. Is this process in statistical control?

(b) Use the trial control limits from part (a) to identify out-of-control points. If necessary, revise your control limits assuming that any samples that plot outside the control limits can be eliminated.

Problem 6) (10 pts) Twenty successive hardness measurements are made on a metal alloy, and the data are given in the data spreadsheet for this assignment.

(a) Using all the data, compute trial control limits for individual observations and moving-range charts. Construct the chart and plot the data. Determine whether the process is in statistical control. If not, assume that assignable causes can be found to eliminate these samples and revise the control limits.

(b) Estimate the process mean and standard deviation for the in-control process.

Problem 7) (5 pts) Suppose that a quality characteristic is normally distributed with specifications at 100 ± 20. The process standard deviation is 6.

(a) Suppose that the process mean is 100. What are the natural tolerance limits? What is the fraction defective? Calculate C_p and C_{pk} and interpret these ratios.

(b) Suppose that the process mean is 106. What are the natural tolerance limits? What is the fraction defective? Calculate C_p and $C_{pk}$and interpret these ratios.

Problem 8) (5 pts) A normally distributed process uses 66.7% (i.e. the +/- 3 σ from the mean) of the specification band. It is centered at the nominal dimension, located halfway between the upper and lower specification limits.

(a) Estimate C_p and C_{pk}. Interpret these ratios.

(b) What fallout level (fraction defective) is produced?

Problem 9) (5 pts) Reconsider problem 1) in which the specification limits are 14.50 ± 0.50.

(a) What conclusions can you draw about the ability of the process to operate within these limits? Estimate the percentage of defective items that is produced.

(b) Estimate C_p and C_{pk}.. Interpret these ratios.

Problem 10) (5pts) Reconsider the pull-strength measurements from problem 4). Estimate the fallout level if the specifications are 16 ± 5. Estimate C_p and interpret this ratio.