STAT3365 Industrial Statistics and TQM
Solutions to Test 1

THURSDAY 13 AUGUST 2009
TIME ALLOWED: 20 MINUTES
This paper contains two questions.
Total Marks = 10

NOTES AND INSTRUCTIONS:

• This test is assessed, and carries weight 5% towards your final mark for this unit.
• The work that you submit for this test must be your sole effort (i.e. not copied from, or discussed with, anyone else).
• The use of any approved calculator is permitted in the test.
• Write your solutions in the spaces provided on this test paper.
• In exercises requiring calculation you must show your working in order to obtain full marks.
• This paper contains 2 pages and a cover sheet. The back page has left blank and you may do your rough working here, but this will not be marked.
• Write your name and student number in the spaces provided at the top of this cover page.

Please do not turn the page until instructed to do so.
Question 1 (5 marks)
A moulding machine process uses a five-cavity mould for a part used in a car assembly. Thus the machine produces a set of five parts at a time. The wall thickness of the part is a critical quality characteristic. It has been suggested to use $\bar{X}$ and $R$ charts to monitor this process, and to use as the subgroup all five parts that are produced at a time.

Briefly discuss this sampling scheme and its impact on the ability of the charts to detect assignable causes of variation. Suggest a better sampling scheme.

Solution
The sub-samples are not independent here. This leads to three problems.

1. Measurements within each groups will be less variable. Thus the true variability of the process will not be reflected. Thus the range charts may deem the process in control because of the low variability, although the process may be out of control.
2. The standard deviation $\sigma$ will be under-estimated.
3. Since the data is correlated, the variance of the sample means is no longer found by $\sigma^2/m$. There is no way to compute this variance since the correlation structure is unknown.

A better sampling scheme is to take a random sample with one observation from each set of parts produced by the machine.

[5 marks]

Question 2 (5 marks)
Measurements were made on the lengths of camshafts at an automobile assembly plant to assess the quality of the process. Five camshafts were measured from each of four shifts daily for five days. An $\bar{X}$ chart of the process is to be plotted to determine if the process is in control.

(a) Given that the sample mean range is 2.72, find an estimate of the standard deviation of the camshaft lengths. Note that $d_2(5) = 2.326$.

Solution

$$\hat{\sigma} = \frac{r}{d_2(5)} = \frac{2.72}{2.326} = 1.169.$$  

[1 mark]

(b) Given that the overall mean of the measurements is 600.065, compute the locations of the UCL and LCL.

Solution

$$UCL = \bar{x} + 3 \times \frac{\hat{\sigma}}{\sqrt{m}} = 600.065 + 3 \times \frac{1.169}{\sqrt{5}} = 601.634.$$  

$$LCL = 600.065 - 3 \times \frac{1.169}{\sqrt{5}} = 598.496.$$  

[2 marks]
(c) A plot of the subgroup means is given in the chart below. Plot the centre-line, the UCL and the LCL on this chart.

Solution

(d) On the basis of the chart, determine if the process is in control. Give a reason to support your answer.

Solution

One of the points lies below the LCL, so the process is deemed out of control.

[1 marks]