**EASTERN MEDITERRANEAN UNIVERSITY**



**Department of Industrial Engineering**

**IENG584 Advanced Quality Engineering**

**HOMEWORK 3 Spring 2018-19**

1. The thickness of a printed circuit board is an important quality parameter. Data on board thickness (in inches) are given in Table 6E.4 for 25 samples of three boards each.
2. Set up  and *R* control charts. Is the process in statistical control?
3. Estimate the process standard deviation.
4. What are the limits that you would expect to contain nearly all the process measurements?
5. If the specifications are at 0.0630 in.  0.0015 in., what is the value of the PCR *Cp*?



1. Sample of *n=6* items each are taken from a process at regular intervals. A quality characteristic is measured and and *R* value are calculated for each sample. After 50 samples, we have:



Assume that the quality characteristic is normally distributed.

1. Compute control limits for theand *R* charts
2. All points on both control charts fall between the control limits computed in part (a). what are the natural tolerance limits of the process?
3. If the specification limits are 41 ± 5, what are your conclusions regarding the ability of the process to produce items within these specifications?
4. Assuming that if an item exceeds the upper specification limit it can be reworked, and if it is below the lower specification limit it must be scrapped, what percent scrap and rework is the process producing?
5. Make suggestions as to how the process performance could be improved.
6. An chart is used to control the mean of a normally distributed quality characteristic. It is known that 6.0 and *n* 4. The center line 200, UCL 209, and LCL 191. If the process mean shifts to 188, find the probability that this shift is detected on the first subsequent sample.
7. Samples of *n* 5 units are taken from a process every hour. The and *R* values for a particular quality characteristic are determined. After 25 samples have been collected, we calculate 20 and 4.56.
   1. What are the three-sigma control limits for and *R*?
   2. Both charts exhibit control. Estimate the process standard deviation.
   3. Assume that the process output is normally distributed. If the specifications are 19 ±5, what are your conclusions regarding the process capability?
   4. If the process mean shifts to 24, what is the probability of not detecting this shift on the first subsequent sample?
8. Control charts for and *R* are to be established to control the tensile strength of a metal part. Assume that tensile strength is normally distributed. Thirty samples of size *n* 6 parts are collected over a period of time with the following results:



1. Calculate control limits for  and *R.*
2. Both charts exhibit control. The specifications on tensile strength are 200 ± 5. What are your conclusions regarding process capability?
3. For the above chart, find the *β*-risk when the true process mean is 199.
4. If the management decided to change the sample size from 6 to 4, calculate the new control limits.
5. Anchart has a center line of 100, uses three-sigma control limits, and is based on a sample size of four. The process standard deviation is known to be six. If the process mean shifts from 100 to 92, what is the probability of detecting this shift on the first sample following the shift?
6. Anchart with three-sigma limits has parameters as follows:

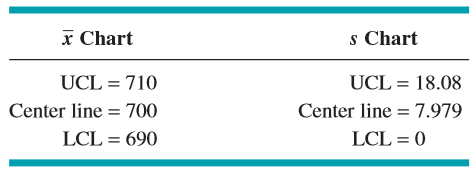
UCL=104

Center line=100

LCL=96

Suppose the process quality characteristic being controlled is normally distributed with a true mean of 98 and a standard deviation of 8. What is the probability that the control chart would exhibit lack of control by at least the third point plotted? Find the ARL1 for the chart.

1. An chart is to be established based on the standard values *µ* 600 and  12, with *n* 9. The control limits are to be based on an *α*-risk of 0.01. What are the appropriate control limits?
2. The following  and s charts based on n = 4 have shown statistical control:



(a) Estimate the process parameters *µ* and s.

(b) If the specifications are at 705 ± 15, and the process output is normally distributed, estimate the fraction nonconforming.

(c) For the chart, find the probability of a type I error, assuming *ơ* is constant.

(d) Suppose the process mean shifts to 693 and the standard deviation simultaneously shifts to 12. Find the probability of detecting this shift on the chart on the first subsequent sample.

(e) For the shift of part (d), find the average run length.