Quality Engineering and Design of Experiments, Spring 2017

Homework #1

Due: 2017/03/23, 09:10

1. (25 pts) The manufacturer of a popular brand of audio speakers was experiencing higher-than-normal field failure with one of their newer products. The source of the problem was identified as a bonded piece of magnetic component. The factors and their levels (Table 1) were studied using an L_8 array (Table 2). The objective of the test was to increase the bonding strength under direct tensile loading. Three test samples in each trial condition were subjected to destructive tests in which the tensile loads were measured using load cells. The loads (in pounds) recorded are listed in Table 3. The S/N ratio is defined as follows:

$$\mathrm{S/N} = -10 \times \log_{10} \frac{\sum_{i=1}^{n} (1/y_i^2)}{n}$$

where *n* is the number of samples in each trial and y_i is the measured tensile load of sample *i*.

(a) Calculate the S/N ratio of each trial.

(b) Establish the response table of S/N ratios.

(c) Make the response graph of S/N ratios.

(d) Assuming the four factors are all significant to the S/N ratio, determine the joint bonding condition that will produce the most strength.

Table 1 Factors and Levels

Factors	Level 1	Level 2
A: adhesive thickness	Current specifications	Thicker
B: base surface	Machined	Rough
C: curing temperature	Ambient	Air convection
D: contact plate	Galvanized	Brass-plated

Table 2 $L_8(2^7)$ array

Exp.	1 (A)	2 (B)	3 (not used)	4 (C)	5 (not used)	6 (not used)	7 (D)
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2

Table 3 Experimental results (loads)

	Sample		
Trial	1	2	3
1	2680	2585	2550
2	1100	1380	1670
3	2035	1830	1645
4	1280	1350	1495
5	2115	2270	2025
6	1815	1830	1870
7	1230	1168	1145
8	1692	1710	1687

2. (15 pts) For a normal distribution with μ as the mean and σ^2 as the variance, verify the followings:
   (a) Under the distribution curve, the area (probability) between $\mu \pm 1.2\sigma$ is around 77%.
   (b) Under the distribution curve, the area (probability) between $\mu \pm 2\sigma$ is around 95%.
   (c) Under the distribution curve, the area (probability) between $\mu \pm 2.5\sigma$ is around 99%.