# 2024 Spring – SPC&O HW#12

1. The yield (as large as possible with the maximum at 100%) of a semiconductor fabrication process has been studied as a function of three factors, at the following experimental levels:

| Variable | Low Level | High Level |
|---|---|---|
| 1. Temperature (°C) | 80 | 120 |
| 2. Pressure (psi) | 50 | 70 |
| 3. Reaction time (min) | 5 | 15 |

A $2^3$ factorial design was performed. Each test, or unique combination of the three variables, was performed three times. The table provides the results of the tests.

| | | | | Trial | | | Yield |
|---|---|---|---|---|---|---|---|
| Test | Temperature | Pressure | Time | 1 | 2 | 3 | Average |
| 1 | 80 | 50 | 5 | 61.43 | 58.58 | 57.07 | 59.03 |
| 2 | 120 | 50 | 5 | 75.62 | 77.57 | 75.75 | 76.31 |
| 3 | 80 | 70 | 5 | 27.51 | 34.03 | 25.07 | 28.87 |
| 4 | 120 | 70 | 5 | 51.37 | 48.49 | 54.37 | 51.41 |
| 5 | 80 | 50 | 15 | 24.80 | 20.69 | 15.41 | 20.30 |
| 6 | 120 | 50 | 15 | 43.58 | 44.31 | 36.99 | 41.63 |
| 7 | 80 | 70 | 15 | 45.20 | 49.53 | 50.29 | 48.34 |
| 8 | 120 | 70 | 15 | 70.51 | 74.00 | 74.68 | 73.07 |

a.) Test the significance with $\alpha$=0.01 of all effects including main effects and interaction effects.

b.) Assuming no effects, plot the Q-Q plot of all the effects.

c.) Build a coded predictive model based on the significant effects found from (a) and (b).

d.) Derive the confidence interval and hypothesis tests for the coefficients ($b_i$) of the coded predictive model ($\alpha$=0.01).

e.) Build a regression model using excel and compare the results to the results of (a).

f.) Calculate the smaller-the-better SN ratios for 100−yield of each experimental result.

g.) Calculate the effects, including interaction effects, on the SN ratio. Use the lowest three interaction effects to estimate the standard error of the effects and test the significance of each effects on the SN ratio.

h.) Assuming no effects, plot the Q-Q plot of the effects on the SN ratio.

i.) Build an SN ratio predictive model based on the significant effects on SN ratio found from (f) and (g).

j.) Suggest an optimum setting for the process to achieve the highest, stable yield based on results of (a)~(i) and compare the results with Problem 3(h) of HW#11.

2. The objective of the “Glove Box Door” experiment in SPCO3.2 is to achieve

parallelism equal to zero.

(a) Calculate the main and interaction effects of the factors on the SN ratio of the parallelisms.

(b) Use the third or higher-order interaction effects to estimate the standard error of the factor effects on the SN-ratio.

(c) Perform *t*-test to determine which factor effects (main and two-factor interaction effects) are statistically significant on the SN ratio with the confidence level $\alpha$=0.01.

(d) Plot Q-Q plot for the main and two-factor interaction effects on the SN ratios.

(e) Use the "significant" effects to build a regression model for the SN ratio.

(f) Use the predictive model for the average (slide 63 of SPCO3.2) and the model built in (e) to optimize the door parallelism.