

SS 11.9 Consider the three-variable central composite design shown in Table P11.4. Analyze the data and draw conclusions, assuming that we wish to maximize conversion (y_1) with activity (y_2) between 55 and 60.

TABLE P11.4					
A Three-Variable CCD					
Run	Time (min)	Temperature (°C)	Catalyst (%)	Conversion (%) y_1	Activity y_2
1	-1.000	-1.000	-1.000	74.00	53.20
2	1.000	-1.000	-1.000	51.00	62.90
3	-1.000	1.000	-1.000	88.00	53.40
4	1.000	1.000	-1.000	70.00	62.60
5	-1.000	-1.000	1.000	71.00	57.30
6	1.000	-1.000	1.000	90.00	67.90
7	-1.000	1.000	1.000	66.00	59.80
8	1.000	1.000	1.000	97.00	67.80
9	0.000	0.000	0.000	81.00	59.20
10	0.000	0.000	0.000	75.00	60.40
11	0.000	0.000	0.000	76.00	59.10
12	0.000	0.000	0.000	83.00	60.60
13	-1.682	0.000	0.000	76.00	59.10
14	1.682	0.000	0.000	79.00	65.90
15	0.000	-1.682	0.000	85.00	60.00
16	0.000	1.682	0.000	97.00	60.70
17	0.000	0.000	-1.682	55.00	57.40
18	0.000	0.000	1.682	81.00	63.20
19	0.000	0.000	0.000	80.00	60.80
20	0.000	0.000	0.000	91.00	58.90

① A full factorial in 3 factors requires $2^3 = 8$ runs. Factorial points are indicated by yellow highlighted cells. $n_f = 8$

② Centerpoints have zeros for x_1, x_2 & x_3 . Pink highlighted cells are centerpoints. $n_c = 6$

③ axial/star points are highlighted in green.

④ The value of $\alpha = 1.682$

if $\alpha = (n_f)^{1/4}$ the design is rotatable
 if $\alpha = \sqrt{k}$ the design is spherical
 otherwise, the value of α is custom

$k = 3, \sqrt{3} = 1.732 \rightarrow$ design is not ~~rotatable~~ ^{spherical}

$n_f = 8 (8)^{1/4} = 1.682 \rightarrow$ design is ~~spherical~~ ^{rotatable}

This is a ~~spherical~~ ^{rotatable} CCD with a full factorial and 6 center points

Note: mistake in hint 1

Week 14 Module A - As a starting point, use the code below.

```
98 ~ ```{r}
99 library(rsm)
100 ccd1.coded <- ccd(4, n0=c(0,6), alpha="rotatable", randomize=FALSE, generators=x5-x1*x2*x3*x4)
101 print(ccd1.coded)
102 ~ ```
```

Recall from hint 1:

- 1) 2^3 (full) factorial,
- 2) 6 center points
- 3) The design is rotatable.

* Notice that no coding information is provided in problem description

* Since full factorial, no generators are needed.

The R code for this problem is

```
ccd(3, n0=c(0,6), alpha="rotatable", randomize=FALSE)
```