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**Introduction to statistical control and optimization**

Homework 15



To meet the requirement of Resolution Ⅴ, the in the fractional factorial design should be 1.

* Design generator:
* Defining relation:
* Resolution: Ⅵ

Number of experimental tests in CCD:

Number of experimental tests in BBD:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| BBD | | | | | | |
| test | x1 | x2 | x3 | x4 | x5 | x6=12345 |
| 1 | -1 | -1 | 0 | 0 | 0 | 0 |
| 2 | -1 | 1 | 0 | 0 | 0 | 0 |
| 3 | 1 | -1 | 0 | 0 | 0 | 0 |
| 4 | 1 | 1 | 0 | 0 | 0 | 0 |
| 5 | -1 | 0 | -1 | 0 | 0 | 0 |
| 6 | -1 | 0 | 1 | 0 | 0 | 0 |
| 7 | 1 | 0 | -1 | 0 | 0 | 0 |
| 8 | 1 | 0 | 1 | 0 | 0 | 0 |
| 9 | -1 | 0 | 0 | -1 | 0 | 0 |
| 10 | -1 | 0 | 0 | 1 | 0 | 0 |
| 11 | 1 | 0 | 0 | -1 | 0 | 0 |
| 12 | 1 | 0 | 0 | 1 | 0 | 0 |
| 13 | -1 | 0 | 0 | 0 | -1 | 0 |
| 14 | -1 | 0 | 0 | 0 | 1 | 0 |
| 15 | 1 | 0 | 0 | 0 | -1 | 0 |
| 16 | 1 | 0 | 0 | 0 | 1 | 0 |
| 17 | 0 | -1 | -1 | 0 | 0 | 0 |
| 18 | 0 | -1 | 1 | 0 | 0 | 0 |
| 19 | 0 | 1 | -1 | 0 | 0 | 0 |
| 20 | 0 | 1 | 1 | 0 | 0 | 0 |
| 21 | 0 | -1 | 0 | -1 | 0 | 0 |
| 22 | 0 | -1 | 0 | 1 | 0 | 0 |
| 23 | 0 | 1 | 0 | -1 | 0 | 0 |
| 24 | 0 | 1 | 0 | 1 | 0 | 0 |
| 25 | 0 | -1 | 0 | 0 | -1 | 0 |
| 26 | 0 | -1 | 0 | 0 | 1 | 0 |
| 27 | 0 | 1 | 0 | 0 | -1 | 0 |
| 28 | 0 | 1 | 0 | 0 | 1 | 0 |
| 29 | 0 | 0 | -1 | -1 | 0 | 0 |
| 30 | 0 | 0 | -1 | 1 | 0 | 0 |
| 31 | 0 | 0 | 1 | -1 | 0 | 0 |
| 32 | 0 | 0 | 1 | 1 | 0 | 0 |
| 33 | 0 | 0 | -1 | 0 | -1 | 0 |
| 34 | 0 | 0 | -1 | 0 | 1 | 0 |
| 35 | 0 | 0 | 1 | 0 | -1 | 0 |
| 36 | 0 | 0 | 1 | 0 | 1 | 0 |
| 37 | 0 | 0 | 0 | -1 | -1 | 0 |
| 38 | 0 | 0 | 0 | -1 | 1 | 0 |
| 39 | 0 | 0 | 0 | 1 | -1 | 0 |
| 40 | 0 | 0 | 0 | 1 | 1 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 |



Check the correlation coefficients among all factors, include quadratic terms.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | x1 | x2 | x1^2 | x2^2 | x1x2 | y |
| x1 | 1 |  |  |  |  |  |
| x2 | 0 | 1 |  |  |  |  |
| x1^2 | 0 | 0 | 1 |  |  |  |
| x2^2 | 0 | 0 | -0.13043 | 1 |  |  |
| x1x2 | 0 | 0 | 0 | 0 | 1 |  |
| y | -0.25697 | 0.190102 | 0.416141 | 0.242749 | 0.553519 | 1 |

It shows that there isn’t any multicollinearity effect among all factors.

Build a second-order model:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 摘要輸出 | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 迴歸統計 | |  |  |  |  |  |  |  |
| R 的倍數 | 0.819441 |  |  |  |  |  |  |  |
| R 平方 | 0.671483 |  |  |  |  |  |  |  |
| 調整的 R 平方 | 0.436828 |  |  |  |  |  |  |  |
| 標準誤 | 4.696548 |  |  |  |  |  |  |  |
| 觀察值個數 | 13 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | 自由度 | SS | MS | F | 顯著值 |  |  |  |
| 迴歸 | 5 | 315.5971 | 63.11942 | 2.861577 | 0.101537 |  |  |  |
| 殘差 | 7 | 154.4029 | 22.05756 |  |  |  |  |  |
| 總和 | 12 | 470 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | 係數 | 標準誤 | t 統計 | P-值 | 下限 95% | 上限 95% | 下限 95.0% | 上限 95.0% |
| 截距 | 41.2 | 2.10036 | 19.61569 | 2.23E-07 | 36.23344 | 46.16656 | 36.23344 | 46.16656 |
| x1 | -1.96967 | 1.66048 | -1.1862 | 0.274238 | -5.89608 | 1.956742 | -5.89608 | 1.956742 |
| x2 | 1.457107 | 1.66048 | 0.877521 | 0.409309 | -2.46931 | 5.383519 | -2.46931 | 5.383519 |
| x1^2 | 3.7125 | 1.780667 | 2.084893 | 0.075537 | -0.49811 | 7.923108 | -0.49811 | 7.923108 |
| x2^2 | 2.4625 | 1.780667 | 1.382909 | 0.209196 | -1.74811 | 6.673108 | -1.74811 | 6.673108 |
| x1x2 | 6 | 2.348274 | 2.555068 | 0.037823 | 0.447215 | 11.55279 | 0.447215 | 11.55279 |

The result shows that the only significant effect is E12, therefore, the prediction model will be:



Objective function:

Subjected to:

The minima is:



Objective function:

Subjected to: