

**SIXTH EDITION**  
**STATISTICS**  
for Engineering and the Sciences  
**STUDENT SOLUTIONS MANUAL**



William M. Mendenhall ■ Terry L. Sincich  
Nancy S. Boudreau

 **CRC Press**  
Taylor & Francis Group  
A CHAPMAN & HALL BOOK

---

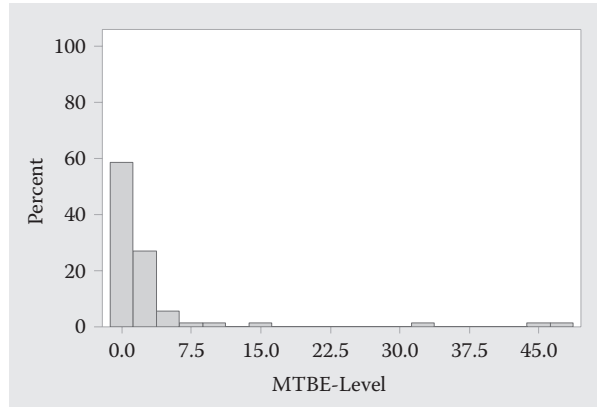
# Contents

---

1. Introduction .....	1
2. Descriptive Statistics .....	5
3. Probability .....	27
4. Discrete Random Variables .....	43
5. Continuous Random Variables .....	63
6. Bivariate Probability Distributions and Sampling Distributions .....	97
7. Estimation Using Confidence Intervals .....	131
8. Tests of Hypotheses .....	157
9. Categorical Data Analysis .....	185
10. Simple Linear Regression .....	205
11. Multiple Regression Analysis .....	245
12. Model Building .....	295
13. Principles of Experimental Design .....	327
14. The Analysis of Variance for Designed Experiments .....	331
15. Nonparametric Statistics .....	373
16. Statistical Process and Quality Control .....	403
17. Product and System Reliability .....	433
Appendix A: Matrix Algebra .....	449

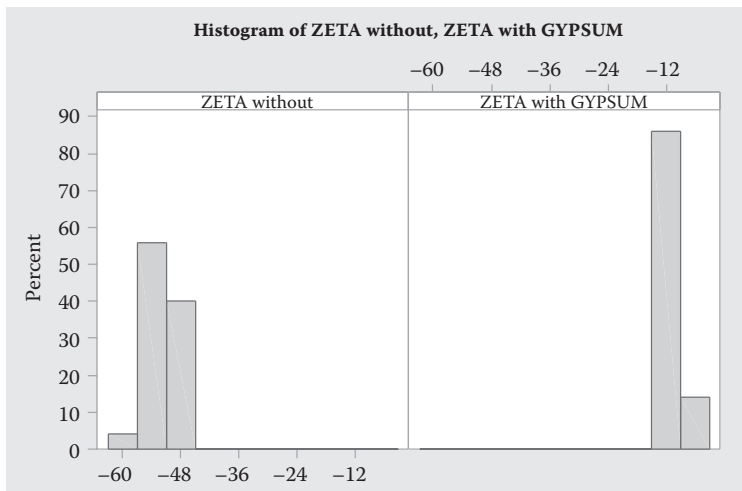
From the histogram, approximately 0.25 of the wells have pH values less than 7.0.

- b. Using MINITAB, the histogram of the MTBE values for contaminated wells is:



From the histogram, approximately 9% of the MTBE values exceed 5 micro-grams per liter.

- 2.23 Using MINITAB, the histograms are:



The addition of calcium/gypsum increases the values of the zeta potential of silica. All of the values of zeta potential for the specimens containing calcium/gypsum are greater than all of the values of zeta potential for the specimens without calcium/gypsum.

- 2.25 a. Assume the data are a sample. The mode is the observation that occurs most frequently. For this sample, there is no mode or all are modes.  
The sample mean is:

$$\bar{y} = \frac{\sum y}{n} = \frac{4 + 3 + 10 + 8 + 5}{5} = \frac{30}{5} = 6$$

# 4

## Discrete Random Variables

- 4.1 a. The number of solar energy cells manufactured in China is a countable number: 0, 1, 2, 3, 4 or 5.

$$b. \quad p(0) = \frac{5!(0.35)^0(0.65)^{5-0}}{0!(5-0)!} = \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{1 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1} (0.35)^0 (0.65)^5 = 0.1160$$

$$p(1) = \frac{5!(0.35)^1(0.65)^{5-1}}{1!(5-1)!} = \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{1 \cdot 4 \cdot 3 \cdot 2 \cdot 1} (0.35)^1 (0.65)^4 = 0.3124$$

$$p(2) = \frac{5!(0.35)^2(0.65)^{5-2}}{2!(5-2)!} = \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{2 \cdot 1 \cdot 3 \cdot 2 \cdot 1} (0.35)^2 (0.65)^3 = 0.3364$$

$$p(3) = \frac{5!(0.35)^3(0.65)^{5-3}}{3!(5-3)!} = \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{3 \cdot 2 \cdot 1 \cdot 2 \cdot 1} (0.35)^3 (0.65)^2 = 0.1811$$

$$p(4) = \frac{5!(0.35)^4(0.65)^{5-4}}{4!(5-4)!} = \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{4 \cdot 3 \cdot 2 \cdot 1 \cdot 1} (0.35)^4 (0.65)^1 = 0.0488$$

$$p(5) = \frac{5!(0.35)^5(0.65)^{5-5}}{5!(5-5)!} = \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 \cdot 1} (0.35)^5 (0.65)^0 = 0.0053$$

- c. The properties of a discrete probability distribution are:

i.  $0 \leq p(y) \leq 1$

ii.  $\sum_{\text{all } y} p(y) = 1$

All of the probabilities above are between 0 and 1. The sum of these probabilities is  $0.1160 + 0.3121 + 0.3361 + 0.1811 + 0.0488 + 0.0053 = 1$ . Thus both properties are met.

d.  $P(Y \geq 4) = p(4) + p(5) = 0.0488 + 0.0053 = 0.0541$

- 4.3 a. To find the probabilities, divide each of the frequencies by the total number of observations, which is 100. The probability distribution of  $Y$  is:

$y$	1	2	3	4
$p(y)$	0.40	0.54	0.02	0.04

b.  $P(Y \geq 3) = p(3) + p(4) = 0.02 + 0.04 = 0.06$

- b. For the geometric distribution,  $\mu = E(Y) = \frac{1}{p}$ . Therefore,

$$\mu = E(Y) = \frac{1}{p} = 3.79 \Rightarrow p = 0.264.$$

- c.  $P(Y = 7) = pq^{7-1} = (0.264)(0.736)^{7-1} = 0.042$

- 4.59 Let  $Y$  = number of shuttle flights until a "critical item" fails. Then  $Y$  is a geometric random variable with  $p = \frac{1}{63}$ .

a.  $\mu = E(Y) = \frac{1}{p} = \frac{1}{1/63} = 63$

b.  $\sigma^2 = \frac{q}{p^2} = \frac{62/63}{(1/63)^2} = 3906 \quad \sigma = \sqrt{3906} = 62.498$

- c. Approximately 0.95 of the observations will fall within 2 standard deviations of the mean. This interval would be  $\mu \pm 2\sigma \Rightarrow 63 \pm 2(62.498) \Rightarrow 63 \pm 124.996 \Rightarrow (-61.996, 187.996) \Rightarrow (0, 188)$ .

- 4.61 a. Let  $S$  = drilling location hits oil and  $F$  = drilling location does not hit oil. If we let  $Y$  = the number of drilling locations until hitting oil, then the probability distribution of  $Y$  is a geometric and the formula is:

$$p(y) = pq^{y-1} = (0.3)(0.7)^{y-1}$$

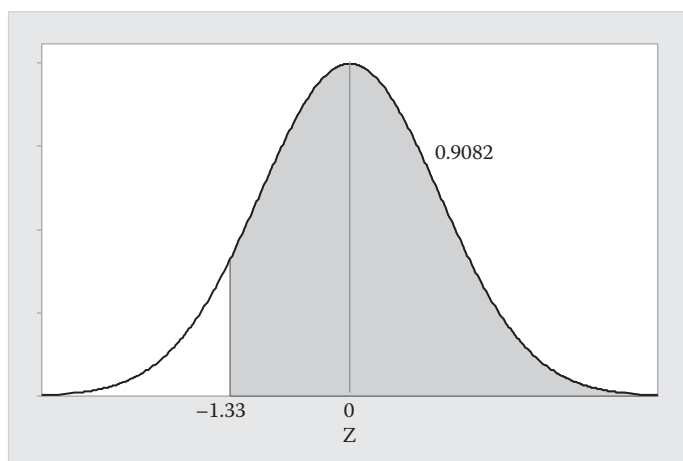
$$P(Y \leq 3) = p(1) + p(2) + p(3) = (0.3)(0.7)^{1-1} + (0.3)(0.7)^{2-1} + (0.3)(0.7)^{3-1} \\ = 0.3 + 0.21 + 0.147 = 0.657$$

b.  $\mu = E(Y) = \frac{1}{p} = \frac{1}{0.3} = 3.3333$

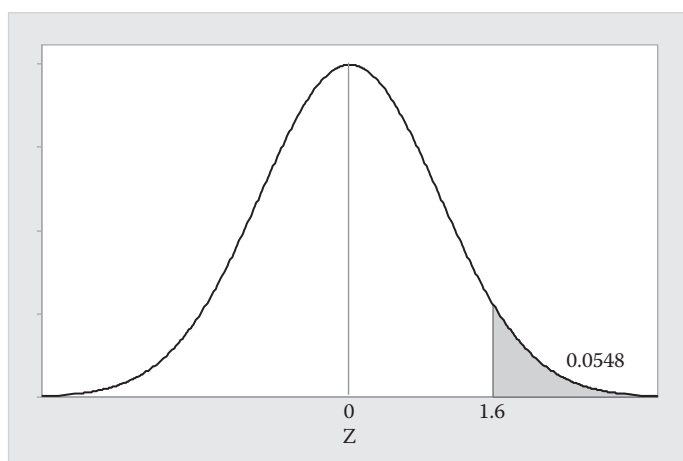
$$\sigma^2 = \frac{q}{p^2} = \frac{0.7}{(0.3)^2} = 7.7778 \quad \sigma = \sqrt{7.7778} = 2.7889$$

- c. No. The value of 10 would be  $z = \frac{x - \mu}{\sigma} = \frac{10 - 3.3333}{2.7889} = 2.39$  standard deviations from the mean. It would be unlikely for observations to be more than 2.39 standard deviations above the mean.
- d. Let  $S$  = drilling location hits oil and  $F$  = drilling location does not hit oil. If we let  $Y$  = the number of drilling locations until the second success occurs, then the probability distribution of  $Y$  is a negative binomial and the formula is:

$$p(y) = \binom{y-1}{r-1} p^r q^{y-r} = \binom{y-1}{2-1} (0.3)^2 (0.7)^{y-2}$$



$$\begin{aligned}
 5.37 \quad P(Y > 3) &= P\left(Z > \frac{3 - 2.2}{0.5}\right) = P(Z > 1.6) = 0.5 - P(0 < Z < 1.6) \\
 &= 0.5 - 0.4452 = 0.0548 \\
 &\text{(using Table 5, Appendix B)}
 \end{aligned}$$



5.39 a. Let  $Y$  = fill of container. Then  $Y$  is normally distributed with  $\mu = 10$  and  $\sigma = 0.2$ .

$$P(Y < 10) = P\left(Z < \frac{10 - 10}{0.2}\right) = P(Z < 0) = 0.5$$

b. Profit = Price – cost – reprocessing fee = \$230 – \$20(10.6) – \$10 = \$230 – \$212 – \$10 = \$8

c. If the probability of underfill is approximately 0, then Profit = Price – Cost.

$$\begin{aligned}
 E(\text{Profit}) &= E(\text{Price} - \text{Cost}) = \$230 - E(\text{Cost}) = \$230 - \$20E(X) \\
 &= \$230 - \$20(10.5) = \$230 - \$210 = \$20
 \end{aligned}$$

- 5.107 Let  $Y$  = number of facies bodies required to satisfactorily estimate  $P$ . Then  $Y$  has an approximate normal distribution with  $\mu = 99$  and  $\sigma = 4.3$ .

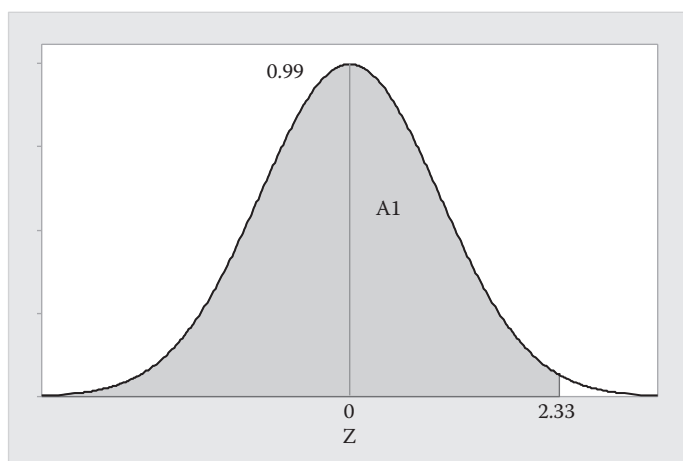
$$P(Y < a) = 0.99 \Rightarrow P\left(Z < \frac{a - 99}{4.3}\right) = P(Z < z_0) = 0.99$$

$A_1 = 0.99 - 0.50 = 0.4900$ . Looking up area 0.4900 in Table 5

gives  $z_0 = 2.33$

$$\Rightarrow z_0 = \frac{a - 99}{4.3} = 2.33 \Rightarrow a - 99 = 10.019 \Rightarrow a = 109.019$$

(using Table 5, Appendix B)



- 5.109 a. The histogram of the data shown is much less spread out than the normal histogram that is superimposed over the data. The normal distribution does not do an adequate job of modeling the data.
- b. The interval  $\mu \pm 2s$  will contain more than 95% of the 400 elevation differences. We would expect 95% of the data to fall in this interval for a normal distribution. Because the spread of the elevation difference data is less than that of a normal distribution, we would expect a higher percentage in the interval  $\mu \pm 2s$ .

- 5.111 Let  $Y$  = time of accident. Then  $Y$  has a uniform distribution on the interval from 0 to 30.

$$P(Y > 25) = (30 - 25) \left( \frac{1}{30} \right) = \frac{5}{30} = \frac{1}{6}$$

- 5.113 a.  $8 = \alpha - 1 \Rightarrow \alpha = 9$  and  $1 = \beta - 1 \Rightarrow \beta = 2$

b.  $\mu = \frac{\alpha}{\alpha + \beta} = \frac{9}{9 + 2} = \frac{9}{11} = 0.8182$

$$\sigma^2 = \frac{\alpha\beta}{(\alpha + \beta)^2(\alpha + \beta + 1)} = \frac{9(2)}{(9 + 2)^2(9 + 2 + 1)} = \frac{18}{(11)^2(12)} = 0.0124$$

For confidence coefficient 0.95,  $\alpha = 0.05$  and  $\alpha / 2 = 0.05 / 2 = 0.025$ . From Table 5, Appendix B,  $z_{0.005} = 1.96$ . The 95% confidence interval is:

$$\begin{aligned}\hat{p} \pm z_{\alpha/2} \sigma_{\hat{p}} &\Rightarrow \hat{p} \pm 1.96 \sqrt{\frac{\hat{p}\hat{q}}{n}} \Rightarrow 0.8182 \pm 1.96 \sqrt{\frac{0.8182(0.1818)}{44}} \\ &\Rightarrow 0.8182 \pm 0.1140 \Rightarrow (0.7042, 0.9322)\end{aligned}$$

Because 0.70 does not fall in the interval, there is evidence that the estimate that less than 70% of aircraft bird strikes occur above 100 feet is not accurate.

- 7.65 a. The point estimate of  $p$ , the true proportion of subjects who use the bright color level as a cue to being right-side-up is  $\hat{p} = \frac{Y}{n} = \frac{58}{90} = 0.644$ .

To see if the sample size is sufficiently large:

$$n\hat{p} = 90(0.644) = 58.0 \geq 4; \quad n\hat{q} = 90(0.356) = 32.0 \geq 4$$

Since both  $n\hat{p} \geq 4$  and  $n\hat{q} \geq 4$ , we may conclude that the normal approximation is reasonable.

For confidence coefficient 0.95,  $\alpha = 0.05$  and  $\alpha / 2 = 0.05 / 2 = 0.025$ . From Table 5, Appendix B,  $z_{0.005} = 1.96$ . The 95% confidence interval is:

$$\begin{aligned}\hat{p} \pm z_{\alpha/2} \sigma_{\hat{p}} &\Rightarrow \hat{p} \pm 1.96 \sqrt{\frac{\hat{p}\hat{q}}{n}} \Rightarrow 0.644 \pm 1.96 \sqrt{\frac{0.644(0.356)}{90}} \\ &\Rightarrow 0.644 \pm 0.099 \Rightarrow (0.545, 0.743)\end{aligned}$$

We are 95% confident that the true proportion of subjects who use the bright color level as a cue to being right-side-up is between 0.545 and 0.743.

- b. Yes. Since both values of the confidence interval are greater than 0.5, we can infer that a majority of subjects would select bright color levels over dark color levels as a cue.
- 7.67 a. The parameter of interest to the researches is the difference in the proportions of producers who are willing to offer windowing services in Missouri and Illinois,  $p_1 - p_2$ .
- b. From the printout, the 99% confidence interval is  $(-0.135179, -0.0031807)$ .
- c. Because the interval contains only negative numbers, there is evidence to indicate that the proportion of producers who are willing to offer windowing services in Missouri is less than the proportion of producers who are willing to offer windowing services in Illinois.
- 7.69 a. The point estimated for the true proportion of super experienced bidders who fall prey to the winner's curse is  $\hat{p}_1 = \frac{Y_1}{n_1} = \frac{29}{189} = 0.1534$ .
- b. The point estimated for the true proportion of less experienced bidders who fall prey to the winner's curse is  $\hat{p}_2 = \frac{Y_2}{n_2} = \frac{32}{149} = 0.2148$ .
- c. To see if the sample size is sufficiently large:
- $$n_1\hat{p}_1 = 189(0.1534) = 29.0 \geq 4; \quad n_1\hat{q}_1 = 189(0.8466) = 160.0 \geq 4$$
- $$n_2\hat{p}_2 = 149(0.2148) = 32.0 \geq 4; \quad n_2\hat{q}_2 = 149(0.7852) = 117.0 \geq 4$$



Since the observed value of the test statistic falls in the rejection region ( $z = 8.34 > 1.96$ ),  $H_0$  is rejected. There is sufficient evidence to indicate that the true proportion of traffic signs maintained by the NCDOT that fail the minimum FHWA retroreflectivity requirements differs from the true proportion of traffic signs maintained by the county that fail the minimum FHWA retroreflectivity requirements at  $\alpha = 0.05$ .

- 8.69 Let  $p_1$  = the true proportion of weevils found dead after 4 days and  $p_2$  = the true proportion of weevils found dead after 3.5 days.

Some preliminary calculations are:

$$\hat{p}_1 = \frac{Y_1}{n_1} = \frac{31,386}{31,421} = 0.99889 \quad \hat{p}_2 = \frac{Y_2}{n_2} = \frac{23,516}{23,676} = 0.99324$$

$$\hat{p} = \frac{Y_1 + Y_2}{n_1 + n_2} = \frac{31,386 + 23,516}{31,421 + 23,676} = 0.99646$$

To compare the mortality rates of adult rice weevils exposed to nitrogen at the two exposure times, we test:

$$H_0 : p_1 - p_2 = 0$$

$$H_a : p_1 - p_2 \neq 0$$

The test statistic is

$$Z = \frac{(\hat{p}_1 - \hat{p}_2) - 0}{\sqrt{\hat{p}\hat{q}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{(0.99889 - 0.99324) - 0}{\sqrt{0.99646(0.00354)\left(\frac{1}{31,421} + \frac{1}{23,676}\right)}} = 11.05.$$

The rejection region requires  $\alpha/2 = 0.10/2 = 0.05$  in each tail of the  $z$  distribution. From Table 5, Appendix B,  $z_{0.05} = 1.645$ . The rejection region is  $z < -1.645$  or  $z > 1.645$ .

Since the observed value of the test statistic falls in the rejection region ( $z = 11.05 > 1.645$ ),  $H_0$  is rejected. There is sufficient evidence to indicate the mortality rates of adult rice weevils exposed to nitrogen differ at the two times at  $\alpha = 0.10$ .

- 8.71 a. Let  $p_1$  = proportion of BE students who withdraw from Engineering Mathematics and let  $p_2$  = proportion of BTech students who withdraw from Engineering Mathematics.

Some preliminary calculations are:

$$\hat{p}_1 = 0.278 \quad \hat{p}_2 = 0.197 \quad \hat{p} = \frac{Y_1 + Y_2}{n_1 + n_2} = \frac{537(0.278) + 117(0.197)}{537 + 117} = 0.2635$$

To determine if the proportion of BE students who withdraw from Engineering Mathematics differs from the proportion of BTech students who withdraw from Engineering Mathematics, we test:

$$H_0 : p_1 - p_2 = 0$$

$$H_a : p_1 - p_2 \neq 0$$

$$SS_{yy} = \sum y^2 - \frac{\left(\sum y\right)^2}{n} = 262.2708 - \frac{60.1^2}{23} = 105.226887$$

$$SS_{xy} = \sum xy - \frac{\sum x \sum y}{n} = 586.95 - \frac{526(60.1)}{23} = -787.51087$$

$$\hat{\beta}_1 = \frac{SS_{xy}}{SS_{xx}} = \frac{-787.51087}{6,906.608696} = -0.114022801 \approx -0.1140$$

$$SSE = SS_{yy} - \hat{\beta}_1 SS_{xy} = 105.226887 - (-0.114022801)(-787.51087) = 15.43269163$$

$$s^2 = \frac{SSE}{n-2} = \frac{15.43269163}{23-2} = 0.734890077 \approx 0.7349$$

$$s = \sqrt{s^2} = \sqrt{0.734890077} = 0.8573$$

e. From Exercise 10.11b,  $\sum y = 45.5$ ,  $\sum y^2 = 214.41$ ,  $SS_{xy} = 54.5766667$ ,  $\hat{\beta}_1 = 1.062436733$

$$SS_{yy} = \sum y^2 - \frac{\left(\sum y\right)^2}{n} = 214.41 - \frac{45.5^2}{15} = 76.393333$$

$$SSE = SS_{yy} - \hat{\beta}_1 SS_{xy} = 76.393333 - (1.062436733)(54.5766667) = 18.40907792$$

$$s^2 = \frac{SSE}{n-2} = \frac{18.40907792}{15-2} = 1.416082917 \approx 1.4161$$

$$s = \sqrt{s^2} = \sqrt{1.416082917} = 1.1900$$

From Exercise 10.11e,  $\sum y = 45.5$ ,  $\sum y^2 = 214.41$ ,  $SS_{xy} = 66.233333$ ,  $\hat{\beta}_1 = 1.021846008$

$$SS_{yy} = \sum y^2 - \frac{\left(\sum y\right)^2}{n} = 214.41 - \frac{45.5^2}{15} = 76.393333$$

$$SSE = SS_{yy} - \hat{\beta}_1 SS_{xy} = 76.393333 - (1.021846008)(66.233333) = 8.71306607$$

$$s^2 = \frac{SSE}{n-2} = \frac{8.71306607}{15-2} = 0.670235851 \approx 0.6702$$

$$s = \sqrt{s^2} = \sqrt{0.670235851} = 0.8187$$

f. From Exercise 10.12,  $\sum y = 135.8$ ,  $\sum y^2 = 769.72$ ,  $SS_{xy} = -130.4416667$ ,  $\hat{\beta}_1 = -0.002310626$

$$SS_{yy} = \sum y^2 - \frac{\left(\sum y\right)^2}{n} = 769.72 - \frac{135.8^2}{24} = 1.31833333$$

# Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
4.74693	98.84%	97.76%	95.36%

# Coefficients

Term	Coef	SE	Coef	T-Value	P-Value	VIF
Constant	56.50	3.36	16.83	0.000		
x1	43.50	4.75	9.16	0.000	4.80	
x2	70.00	4.75	14.75	0.000	4.80	
x3	22.50	4.75	4.74	0.000	4.80	
x4	-26.00	4.75	-5.48	0.000	4.80	
x5	20.50	4.75	4.32	0.001	6.67	
x6	4.50	4.75	0.95	0.358	6.67	
x1x5	-38.50	6.71	-5.73	0.000	3.73	
x1x6	-59.00	6.71	-8.79	0.000	3.73	
x2x5	-46.50	6.71	-6.93	0.000	3.73	
x2x6	-2.50	6.71	-0.37	0.715	3.73	
x3x5	-20.50	6.71	-3.05	0.008	3.73	
x3x6	-10.00	6.71	-1.49	0.157	3.73	
x4x5	-14.50	6.71	-2.16	0.047	3.73	
x4x6	-12.00	6.71	-1.79	0.094	3.73	

# Regression Equation

$$\text{FEED} = 56.50 + 43.50 \text{ x1} + 70.00 \text{ x2} + 22.50 \text{ x3} - 26.00 \text{ x4} + 20.50 \text{ x5} \\ + 4.50 \text{ x6} - 38.50 \text{ x1x5} - 59.00 \text{ x1x6} - 46.50 \text{ x2x5} - 2.50 \text{ x2x6} \\ - 20.50 \text{ x3x5} - 10.00 \text{ x3x6} - 14.50 \text{ x4x5} - 12.00 \text{ x4x6}$$

$$\text{SSE}_c = 338.00$$

The results from fitting the reduced model without the interaction terms are:

**Regression Analysis: FEED versus x1, x2, x3, x4, x5, x6**

# Analysis of Variance

Source	DF	Adj SS	Ad jMS	F-Value	P-Value
Regression	6	24855.1	4142.52	22.17	0.000
x1	1	363.0	363.00	1.94	0.177
x2	1	8640.3	8640.33	46.25	0.000
x3	1	456.3	456.33	2.44	0.132
x4	1	3640.1	3640.08	19.49	0.000
x5	1	61.3	61.25	0.33	0.572
x6	1	744.2	744.20	3.98	0.058
Error	23	4296.7	186.81		
Lack-of-Fit	8	3958.7	494.84	21.96	0.000
Pure Error	15	338.0	22.53		
Total	29	29151.9			

# Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
13.6680	85.26%	81.42%	74.92%

15.61 The 36 arrangements along with the corresponding  $r_s$  values are:

$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$
1	1	1	1	1	2	1	2	1	3	1	3
2	2	2	3	2	1	2	3	2	1	2	2
3	3	3	2	3	3	3	1	3	2	3	1
$r_s = 1$		$r_s = 0.5$		$r_s = 0.5$		$r_s = -0.5$		$r_s = -0.5$		$r_s = -1$	
$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$
1	1	1	1	1	2	1	2	1	3	1	3
3	2	3	3	3	1	3	3	3	1	3	2
2	3	2	2	2	3	2	1	2	2	2	1
$r_s = 0.5$		$r_s = 1$		$r_s = -0.5$		$r_s = 0.5$		$r_s = -1$		$r_s = -0.5$	
$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$
2	1	2	1	2	2	2	2	2	3	2	3
1	2	1	3	1	1	1	3	1	1	1	2
3	3	3	2	3	3	3	1	3	2	3	1
$r_s = 0.5$		$r_s = -0.5$		$r_s = 1$		$r_s = -1$		$r_s = 0.5$		$r_s = -0.5$	
$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$
2	1	2	1	2	2	2	2	2	3	2	3
3	2	3	3	3	1	3	3	3	1	3	2
1	3	1	2	1	3	1	1	1	2	1	1
$r_s = -0.5$		$r_s = 0.5$		$r_s = -1$		$r_s = 1$		$r_s = -0.5$		$r_s = 0.5$	
$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$
3	1	3	1	3	2	3	2	3	3	3	3
1	2	1	3	1	1	1	3	1	1	1	2
2	3	2	2	2	3	2	1	2	2	2	1
$r_s = -0.5$		$r_s = -1$		$r_s = 0.5$		$r_s = -0.5$		$r_s = 1$		$r_s = 0.5$	
$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$	$u$	$v$
3	1	3	1	3	2	3	2	3	3	3	3
2	2	2	3	2	1	2	3	2	1	2	2
1	3	1	2	1	3	1	1	1	2	1	1
$r_s = -1$		$r_s = -0.5$		$r_s = -0.5$		$r_s = 0.5$		$r_s = 0.5$		$r_s = 1$	

Since each of the 36 arrangements are equally likely, each has a probability of  $1/36$ .

$$E(r_s) = \sum r_s p(r_s) = 1 \left( \frac{1}{36} \right) + 0.5 \left( \frac{1}{36} \right) + 0.5 \left( \frac{1}{36} \right) - 0.5 \left( \frac{1}{36} \right) + \cdots + 1 \left( \frac{1}{36} \right) = 0$$