Errata and Corrigenda for *Statistics for Chemical and Material Engineers: A Modern Approach*

Last Update: December 18nd, 2018

Page, line	Current Form	Correction
p.8, Equation (1.19) and line before	σ_{mad}	$\hat{\sigma}_{rob}$ [1]
p. 35, last Equation	$f(x)=\frac{3}{8}x^3$	$f(x)=\frac{3}{8}x^2$ should be *squared* rather than *cubed*.
p. 37, last equation of Example 2.4	$E(3XY)=3E(XY)$ $=3\big(E(X)E(Y)+\operatorname{cov}(X,Y)\big)=3\big((5)(2)-2\big)$ $=24$	$E(3XY)=3E(XY)$ $=3\big(E(X)E(Y)+\operatorname{cov}(X,Y)\big)=3\big((5)(2)+2\big)$ $=36$ It should be "+2" rather than "−2" in the second line of the equation. As well, this will then change the final answer.

[1] This makes the symbols consistent and also emphasis that we are dealing with the robust estimate of the standard deviation.

Page, line	Current Form	Correction
p. 41 (last Equation on page)	$\mu_Z = \int_0^\infty z f_Z(z)\,dy = \int_0^\infty 4ze^{-4z}dy = 4\times\frac{1}{16} = 0.25$	$\mu_Z = \int_0^\infty z f_Z(z)\,dy = \int_0^\infty 4ze^{-4z}d\underline{z} = 4\times\frac{1}{16} = 0.25$ [2]
p. 43, Section 4.2, line 6	Except for the last three distributions which are discrete	Except for the last **two** distributions which are discrete
p. 55, Equation (2.41)	$\ell(\theta\|\vec{x}) = \log L(\theta\|\vec{x}) = \sum_{i=1}^{n} f(x_i,\theta)$	$\ell(\theta\|\vec{x}) = \log L(\theta\|\vec{x}) = \sum_{i=1}^{n}\log f(x_i,\theta)$ The **log** is missing from the summation.
p. 63, bullet #3, line 2	…for a small initial confidence intervals.	*remove these words.*
p. 64, line 12	…variance is known (in which it should be used in lieu of σ) or n > 30.	…variance is known (in which **<u>case</u>** it should be used in lieu of σ) or n > 30.
p. 68, Example 2.13, line 5	…during 40 h of operation.	…during **50** h of operation.
p.73, lines 1/2	Example 2.15: Testing the Difference in Means—Unknown, Common Mean	Example 2.15: Testing the Difference in Means—Unknown, Common **<u>Variance</u>**

[2] *dy* should be replaced by *dz*.

Page, line	Current Form	Correction
p. 77 (last line of the page)	(not centred)	(centred; The formula should be centred on the page.)
p. 81, Equation (2.68)	$x \geq 0$	$\underline{\boldsymbol{y}} \geq 0$
p. 96, Equation (3.18)	$\sigma_{\hat{\hat{\beta}}}^2 = E\left(\varepsilon\varepsilon^T\right) = \sigma^2 \mathcal{I}$	$\underline{\sigma_{\varepsilon}^2} = E\left(\varepsilon\varepsilon^T\right) = \sigma^2 \mathcal{I}$
p. 106, line 14	13.5±0.4 kg·m^{-1}	13.**<u>4</u>**±0.4 kg·m^{-1}
p. 106, line 18	14±1 kg·m^{-1}	1**<u>3</u>**±1 kg·m^{-1}
Table 3.2 (fifth cell)	Prounanced Tails	**<u>Pronounced</u>** Tails
p. 119, Example 3.2	…(consider replicates 2 and 3 of run 2).	…(consider replicates 2 and 3 of **Run 3**).
p. 139, Section A.2	The ordinary, least-squares problem can be solved by first computing the following two quantities	The **weighted**, least-squares problem can be solved by first computing the following two quantities

Page, line	Current Form	Correction
p. 156, first two lines	see footnote [3]	see footnote [4] The equations are too large to show otherwise and all entries are wrong.
p. 156f, Example 4.2, b), c), and d)	*Some of the comments for question b), c), and d) are not correct given the error in the computation of the parameter values.*	*Please see Appendix I: Correction for Example 4.2 for the updated version.*
p. 159, §4.5.3.1, first sentence of paragraph 3	where x is the divisor and y is the dividend (or base)	where x is the **dividend** and y is the **divisor** (or base)

---

[3]
$$\hat{\hat{\beta}} = 2^{-4}\mathcal{A}^T\vec{y} = \begin{bmatrix} 101 & 5.19 & -0.813 & -2.19 & 3.06 & -0.0625 & -7.69 & -0.438 & 0.813 & 0.813 & \ldots \\ & & \ldots & & & -0.313 & 0.313 & -0.188 & -0.0625 & 0.188 & -0.313 \end{bmatrix}^T \text{ (original)}$$

[4]
$$\hat{\hat{\beta}} = 2^{-4}\mathcal{A}^T\vec{y} = \begin{bmatrix} 70.06 & 10.81 & 1.56 & 4.94 & 7.31 & 0.0625 & -9.06 & 8.31 & 1.19 & -0.188 & \ldots \\ & & \ldots & & & -0.563 & 0.938 & 2.063 & -0.813 & -1.32 & 0.688 \end{bmatrix}^T \text{ (corrected)}$$

Page, line	Current Form	Correction
p. 180, Equation (4.39)	$\gamma_{ji} = \sum_{k=0}^{\frac{j}{2}} \beta_{jk} x_i^k$	$\gamma_{ji} = \sum_{k=0}^{\frac{j}{2}} \beta_{jk} x_i^{2k}$ The superscript on the *x* should be ***2k*** rather than *k*.
p. 182, line 6 (right after Eq. 4.51)	$\gamma_{11} + \gamma_{12} + \gamma_{13} = 0$	$\gamma_{\underline{\mathbf{2}}1} + \gamma_{\underline{\mathbf{2}}2} + \gamma_{\underline{\mathbf{2}}3} = 0$
p. 182, line 7 (right after Eq. 4.51)	(6 unknowns, but 5 equations)	(**<u>5</u>** unknowns, but **<u>4</u>** equations)
p. 182, line 8 (right before Eq. 4.52)	$\gamma_{13} = \gamma_{11} = 1$	$\gamma_{\underline{\mathbf{2}}3} = \gamma_{\underline{\mathbf{2}}1} = 1$
p. 184, Equation (4.55), 4th line	$\gamma_{13} = \beta_{11} x_4 = \beta_{11}(1)$	$\gamma_{14} = \beta_{11} x_4 = \beta_{11}(1)$ It should be $\boldsymbol{\gamma_{14}}$ rather than $\boldsymbol{\gamma_{13}}$.
p. 184, Equation (4.56)	$\gamma_{11} = -1, \gamma_{12} = -1/3, \gamma_{12} = 1/3, \gamma_{13} = 1$ $\beta_{11} = 1$	$\gamma_{11} = -1, \gamma_{12} = -1/3, \gamma_{13} = 1/3, \gamma_{14} = 1$ $\beta_{11} = 1$ The second γ_{12} should read as $\boldsymbol{\gamma_{13}}$ and the γ_{13} as $\boldsymbol{\gamma_{14}}$.

Page, line	Current Form	Correction
p. 185, line 7 (right after Eq. 4.61)	$\gamma_{11} + \gamma_{12} + \gamma_{13} + \gamma_{14} = 0$	$\gamma_{\underline{2}1} + \gamma_{\underline{2}2} + \gamma_{\underline{2}3} + \gamma_{\underline{2}4} = 0$
p. 185, line 8 (right after Eq. 4.61)	$\gamma_{13} = \gamma_{12}$ and $\gamma_{14} = \gamma_{11}$	$\gamma_{\underline{2}3} = \gamma_{\underline{2}2}$ and $\gamma_{\underline{2}4} = \gamma_{\underline{2}1}$
p. 185, line 9 (right before Eq. 4.62)	$\gamma_{13} = \gamma_{12} = -1$	$\gamma_{\underline{2}3} = \gamma_{\underline{2}1} = -1$
p. 185, line 14 (right after Eq. 4.63)	$\gamma_{11} + \gamma_{12} + \gamma_{13} + \gamma_{14} = 0$	$\gamma_{\underline{3}1} + \gamma_{\underline{3}2} + \gamma_{\underline{3}3} + \gamma_{\underline{3}4} = 0$
p. 185, line 16 (right after Eq. 4.63)	$\gamma_{13} = -\gamma_{12}$ and $\gamma_{14} = -\gamma_{11}$	$\gamma_{\underline{3}3} = -\gamma_{\underline{3}2}$ and $\gamma_{\underline{3}4} = -\gamma_{\underline{3}1}$
p. 185, line 18 (right after Eq. 4.63)	$\gamma_{11} = -1, \ldots, \gamma_{14} = 1$, and $\gamma_{12} = 1$	$\gamma_{\underline{3}1} = -1, \ldots, \gamma_{\underline{3}4} = 1$, and $\gamma_{\underline{3}2} = 1$

Page, line	Current Form	Correction
p. 185, line 19 (right before Eq. 4.64)	$\gamma_{13} = -1$	$\gamma_{\underline{\mathbf{3}}3} = -1$
p. 188, Equation (4.70)	$\tilde{x}_1 = \frac{x_1 - 0.5(14+10)}{0.5(14-10)} = 0.5x_1 - 6$ $\tilde{x}_2 = \frac{x_3 - 0.5(25+30)}{0.5(30-25)} = 0.4x_2 - 11$ $\tilde{x}_3 = \frac{x_2 - 0.5(200+250)}{0.5(250-200)} = 0.04x_3 - 9$	$\tilde{x}_1 = \frac{x_1 - 0.5(14+10)}{0.5(14-10)} = 0.5x_1 - 6$ $\tilde{x}_2 = \frac{x_2 - 0.5(25+30)}{0.5(30-25)} = 0.4x_2 - 11$ $\tilde{x}_3 = \frac{x_3 - 0.5(200+250)}{0.5(250-200)} = 0.04x_3 - 9$ In the second and third equations, after the first equals sign, x_3 (in the second equation) should be $\boldsymbol{x_2}$ and x_2 (in the third equation) should be $\boldsymbol{x_3}$.
p. 189, Section 4.7.4.4	$L_2(\tilde{x}_1) = 3\tilde{x}_1 - 2$	$L_2(\tilde{x}_1) = 3\tilde{x}_1^{\mathbf{2}} - 2$

Page, line	Current Form	Correction
p. 189, Equation (4.72)[5]	$\mathcal{A}_{part} = \begin{bmatrix} 1 & -1 & -1 & -1 & 1 & 1 & 1 & -1 & 1 & -1 & -1 & 1 \\ 1 & -1 & -1 & 1 & 1 & -1 & -1 & 1 & 1 & -1 & 1 & -1 \\ 1 & -1 & 1 & -1 & -1 & 1 & -1 & 1 & 1 & 1 & -1 & -1 \\ 1 & -1 & 1 & 1 & -1 & -1 & 1 & -1 & 1 & 1 & 1 & -2 \\ 1 & 0 & -1 & -1 & 0 & 0 & 1 & 0 & -2 & 2 & 2 & 2 \\ 1 & 0 & -1 & 1 & 0 & 0 & -1 & 0 & -2 & 2 & -2 & 2 \\ 1 & 0 & 1 & -1 & 0 & 0 & -1 & 0 & -2 & -2 & 2 & -2 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & -2 & -2 & -2 & 1 \\ 1 & 1 & -1 & -1 & -1 & -1 & 1 & 1 & 1 & -1 & -1 & -1 \\ 1 & 1 & -1 & 1 & -1 & 1 & -1 & -1 & 1 & -1 & 1 & -1 \\ 1 & 1 & 1 & -1 & 1 & -1 & -1 & -1 & 1 & 1 & -1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$	$\mathcal{A}_{part} = \begin{bmatrix} 1 & -1 & -1 & -1 & 1 & 1 & 1 & -1 & 1 & -1 & -1 & 1 \\ 1 & -1 & -1 & 1 & 1 & -1 & -1 & 1 & 1 & -1 & 1 & 1 \\ 1 & -1 & 1 & -1 & -1 & 1 & -1 & 1 & 1 & 1 & -1 & -1 \\ 1 & -1 & 1 & 1 & -1 & -1 & 1 & -1 & 1 & 1 & 1 & -1 \\ 1 & 0 & -1 & -1 & 0 & 0 & 1 & 0 & -2 & 2 & 2 & -2 \\ 1 & 0 & -1 & 1 & 0 & 0 & -1 & 0 & -2 & 2 & -2 & 2 \\ 1 & 0 & 1 & -1 & 0 & 0 & -1 & 0 & -2 & -2 & 2 & 2 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & -2 & -2 & -2 & -2 \\ 1 & 1 & -1 & -1 & -1 & -1 & 1 & 1 & 1 & -1 & -1 & 1 \\ 1 & 1 & -1 & 1 & -1 & 1 & -1 & -1 & 1 & -1 & 1 & -1 \\ 1 & 1 & 1 & -1 & 1 & -1 & -1 & -1 & 1 & 1 & -1 & -1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$
p. 189, Equation (4.74)[6]	$\vec{y} = \begin{bmatrix} \cdots & 1 & 1 & 3 & 1 & 5 & 4 & 9 & 6 & 11 \end{bmatrix}^T$	$\vec{y} = \begin{bmatrix} \cdots & 1 & 1 & \mathbf{1} & \mathbf{3} & 5 & 4 & \mathbf{6} & \mathbf{9} & 11 \end{bmatrix}^T$
p. 191, Figure 4.8	β_{13}	$\beta_{1\underline{\mathbf{2}}}$

[5] The last column of the matrix was shifted up by one row. The corrected matrix is provided. All subsequent calculations are still correct.
[6] Only the last 9 elements of this vector are shown. Two groups of two digits were transposed. All subsequent calculations are still correct.

Page, line	Current Form	Correction
p. 191, Figures 4.10, 4.11	*There seems to be some minor differences in the graphs due to ordering of variables. The interpretation and final results are not affected.*	*See Appendix II: Updating the Figures for the Example in §4.7.4 for the updated figures.*
p. 196, Equation (4.90)	$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_{12} x_{12} + \beta_c x^2$	$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_{12} x_1 x_2 + \beta_c x^2$ The third term, $\beta_{12}x_{12}$, should be $\boldsymbol{\beta_{12}x_1x_2}$.
p. 220, Equation (5.27)	$A_Q\left(z^{-s}\right) = 1 + \sum_{i=1}^{P} \alpha_{si} z^{-si},$ $B_P\left(z^{-s}\right) = 1 + \sum_{i=1}^{Q} \beta_{si} z^{-si}.$	$\underline{A_P}\left(z^{-s}\right) = 1 + \sum_{i=1}^{P} \alpha_{si} z^{-si},$ $\underline{B_Q}\left(z^{-s}\right) = 1 + \sum_{i=1}^{Q} \beta_{si} z^{-si}.$
p. 221, right after Equation (5.27)	The pure seasonal autoregressive model…	The pure seasonal **<u>moving average</u>** model…
p. 226, computation of σ_y, 3rd line	$= \sigma^2 + 0.5^2\sigma^2 + 0.1\sigma^2 =$	$= \sigma^2 + 0.5^2\sigma^2 + \underline{0.1^2}\sigma^2 =$
p. 256, 2-step-ahead	$\hat{\sigma}^2_{102\|100} = 1.0807\left(1^2 + 0.436^2\right) = 1.2708$	$\hat{\sigma}^2_{102\|100} = 1.0807\left(1^2 + 0.436^2\right) = \underline{1.286}$

Page, line	Current Form	Correction
p. 268, Equation (5.134)	$\mathcal{K}_t = \Sigma_{t-1\|t}\mathcal{C}^T\left(\mathcal{C}\Sigma_{t-1\|t}\mathcal{C}^T + \Sigma_e\right)$	$\mathcal{K}_t = \Sigma_{t-1\|t}\mathcal{C}^T\left(\mathcal{C}\Sigma_{t-1\|t}\mathcal{C}^T + \Sigma_e\right)^{\underline{-1}}$
pp. 287 – 289	*m*-step	<u>***τ***</u>-step
p. 288, line 4	where some *L* is a rational function of z^{-1}	where <u>***L* is some rational**</u> function of z^{-1}
p. 293, Equation (6.31) p. 293, line after Equation (6.31)	$t\|t-1$	<u>***t* + 1|*t***</u> (Note both formulations are equivalent, but for consistency, we should use the corrected form.)
p. 294, Equation (6.41)	$\operatorname{var}\left(\varepsilon_t\left(\vec{\theta},\hat{\vec{\theta}}\right)\right) = \operatorname{var}\left(\Phi_e\left(z^{-1},\vec{\theta},\hat{\vec{\theta}}\right)u_t\right) + \operatorname{var}\left(\left(\Phi_e\left(z^{-1},\vec{\theta},\hat{\vec{\theta}}\right) - \mathcal{I}\right)e_t\right) + \operatorname{var}\left(e_t\right)$	$\operatorname{var}\left(\varepsilon_t\left(\vec{\theta},\hat{\vec{\theta}}\right)\right) = \operatorname{var}\left(\boldsymbol{\Phi_u}\left(z^{-1},\vec{\theta},\hat{\vec{\theta}}\right)u_t\right) + \operatorname{var}\left(\left(\Phi_e\left(z^{-1},\vec{\theta},\hat{\vec{\theta}}\right) - \mathcal{I}\right)e_t\right) + \operatorname{var}\left(e_t\right)$ The first $\boldsymbol{\Phi_e}$ should be $\boldsymbol{\Phi_u}$ instead.

Page, line	Current Form	Correction
p. 303, first paragraph of §6.4	In such cases, using and understanding routine operating data **are** important.	In such cases, using and understanding routine operating data **is** important.
p. 310, §6.5.1, second paragraph	Weiner-Hammerstein models are useful with the actuators or sensors have…	**Wiener**-Hammerstein models are useful with the actuators or sensors have…
p. 316, Equation (6.82), second line	$\frac{\left(7.8\times10^{-4}\pm2\times10^{-5}\right)z^{-2}}{1-\left(1.664\pm0.007\right)z^{-1}+\left(0.695\pm0.007\right)z^{-1}}u_2$	$\frac{\left(7.8\times10^{-4}\pm2\times10^{-5}\right)z^{-2}}{1-\left(1.664\pm0.007\right)z^{-1}+\left(0.695\pm0.007\right)\underline{z^{-2}}}u_2$
p. 340, Table 7.3	start, *	**star,** *
p. 311, Fig. 6.2		(See Figure 1 for the corrected image, which clarifies the relationship between the flows in the 4 tanks.)
p. 353, line 24	`%Obtain the autocorrelation values`	`%Obtain the` **`cross`**`correlation values`
p. 356, third computer text box	`A=A([1, size(A,1)],:);`	`A=A([1,` **`3:`**`size(A,1)],:);`

Page, line	Current Form	Correction
p. 359, first line of second computer text box	`%Script for solving linear regression problems in MATLAB`	`%Script for solving` **<u>`nonlinear`</u>** `regression problems in MATLAB`
p. 361, computer text box	`cm/s`	`cm`**<u>`^3`</u>**`/s`
p. 363	Microsoft Office 2013	Microsoft Office **<u>2016</u>**
p. 374, §8.5	In order to start Solver, in Excel 2007 or newer,… Solver should be there as shown in Fig. 8.7.	In order to start **<u>the Data Analysis Add-In</u>**, in Excel 2007 or newer,… **<u>The Data Analysis Add-In</u>** should be there as shown in Fig. 8.7.
p. 379, item 3)	Median – Q1, Q3, and Maximum – Q3	Median – Q1, **<u>Q3 − Median</u>**, and Maximum – Q3
p. 379, item 4)	Q3	**<u>Q3 – Median</u>**

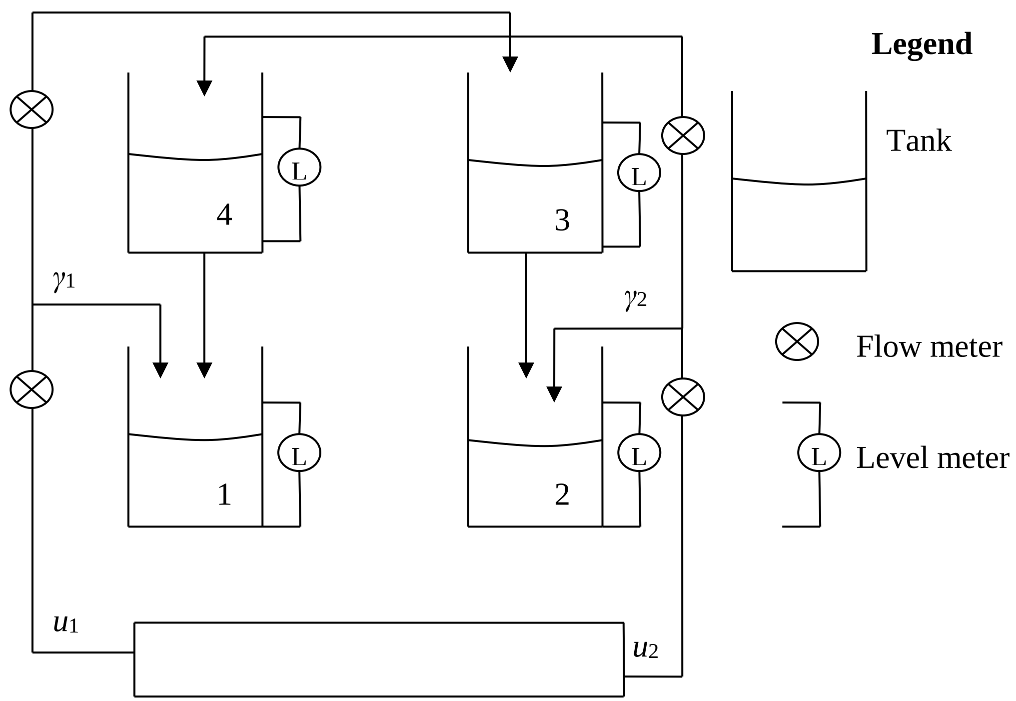

Figure 1: Corrected Fig. 6.2

Yuri A.W. Shardt would like to thank his students in the *Intelligent Regelung* (en: *Smart Control*) course, Thomas Donnelly, Alexandru Vasile, and Heiko Weiß for pointing out typos and unclear sections.

Appendix I: Correction for Example 4.2, Parts b), c), and d)

b) A normal probability plot of the effects is shown in Figure 37. **The effects that lie far from the expected normal distribution values are those that are significant because they are not chance values. The most significant effects have been circled and labelled. Therefore, the significant effects are those denoted as A, C, D, and AC. The effect due to B is negligible.**

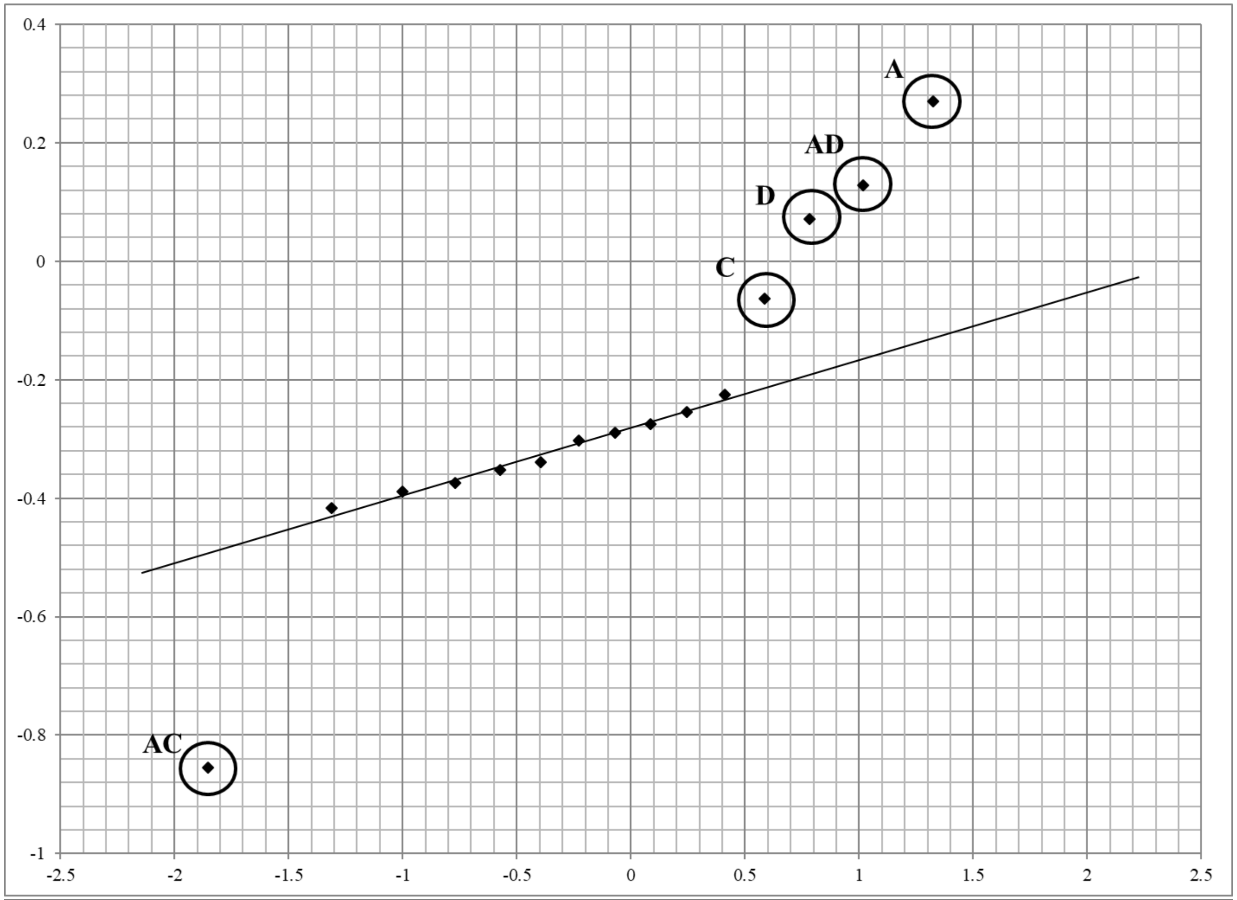

Figure 37: Normal probability plot of the effects

c) Dropping the B factor will produce a 2^3-factorial experiment with 2 replicates. In addition to dropping the terms associated with the B factor, all other terms will also be dropped. Since the design is orthogonal, we can drop the terms, without needing to recalculate anything. Therefore, the simplified model is given as

$$\underline{y = 70.06 + 10.8x_1 + 4.94x_3 + 7.31x_4 - 9.06x_1x_3 + 8.31x_1x_4}$$

d) The residuals for this case are shown in Figure 38. It can be seen that they are more or less normally distributed. Furthermore, since the reduced model has an $\underline{\boldsymbol{R^2 = 0.966}}$ with all significant parameter values, it can be concluded that the results are probably good.

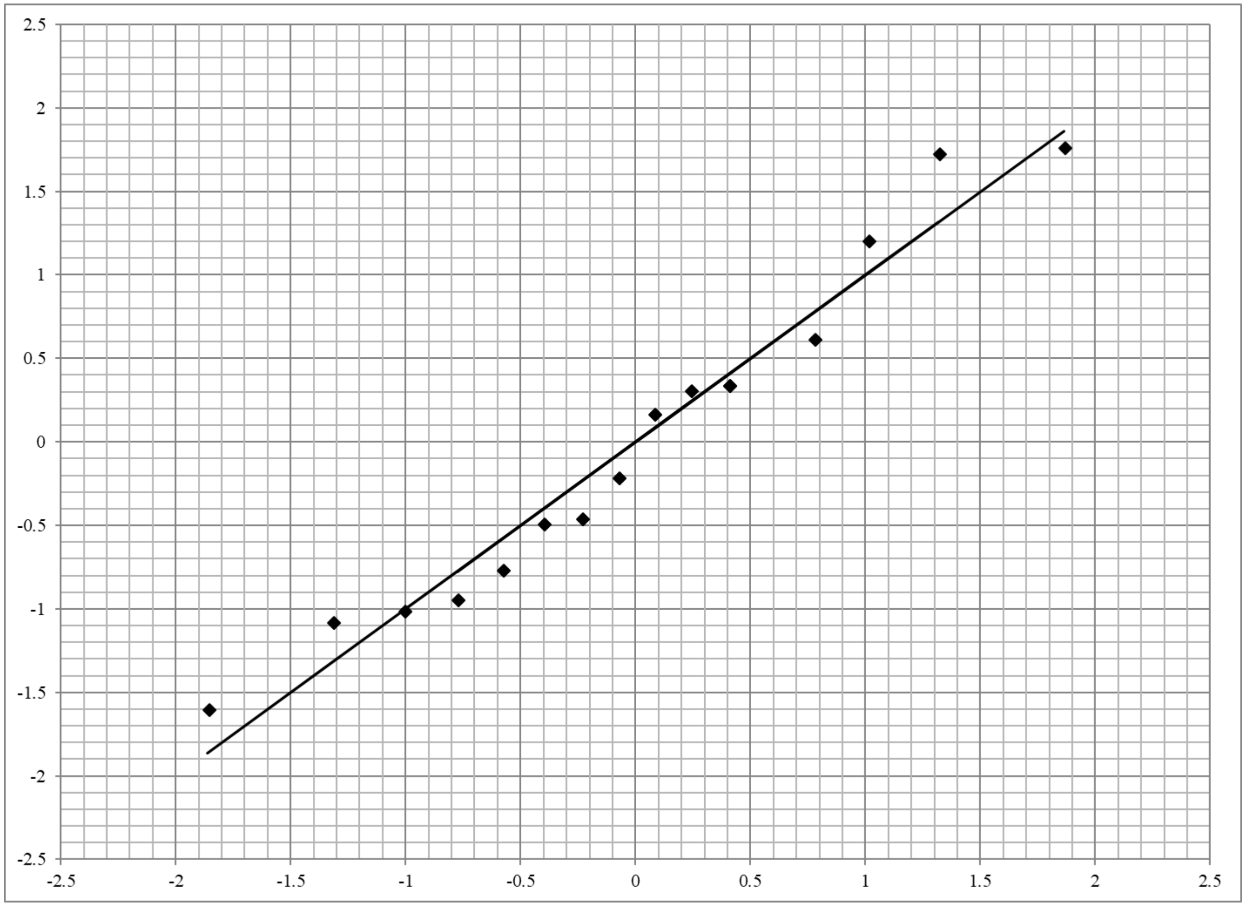

Figure 38: Normal probability plot of the residuals for the reduced model

Appendix II: Updating Figures 44 and 45 for the Example in §4.7.4

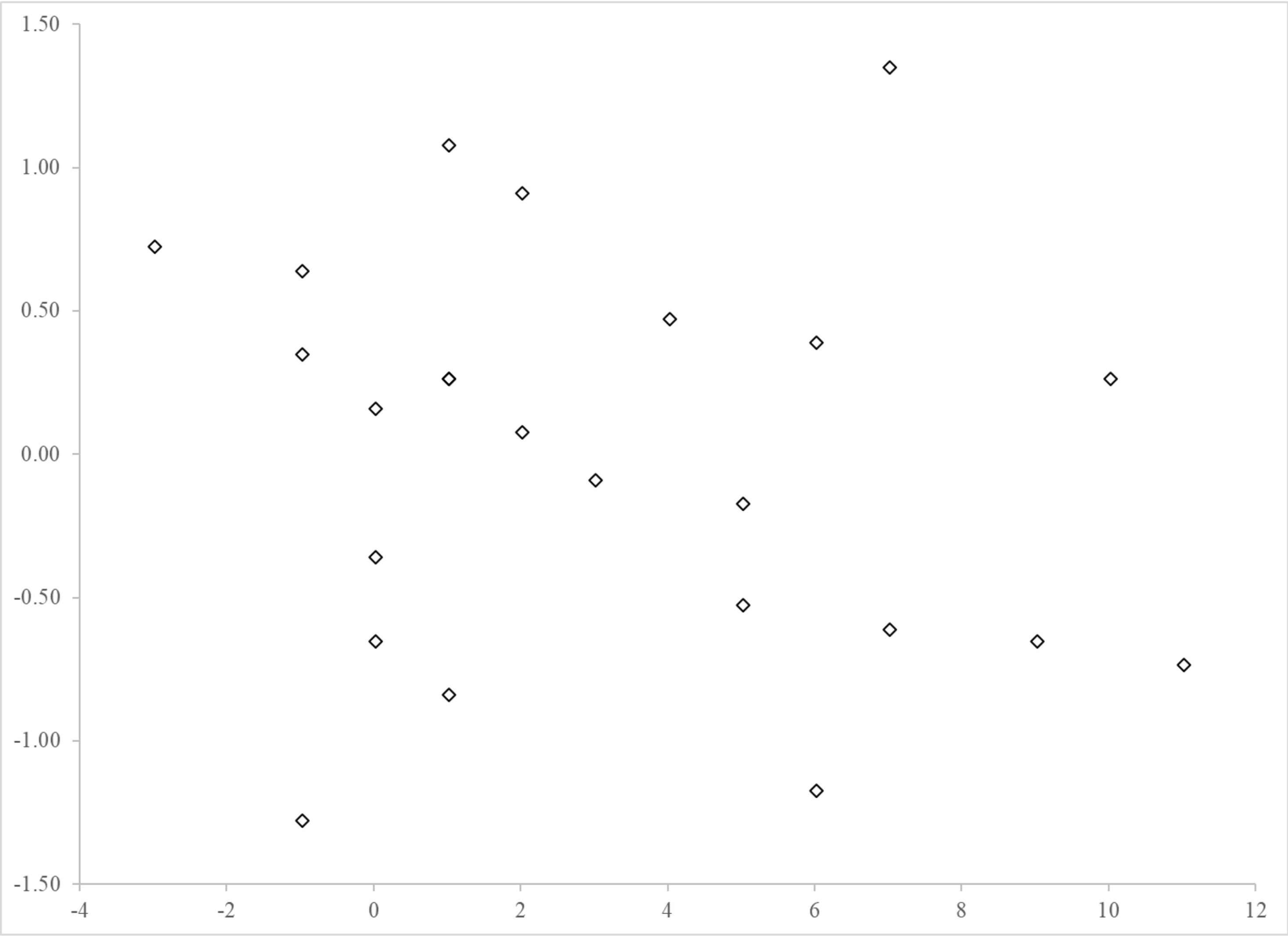

Figure 44: Residuals as a function of $\hat{y}$

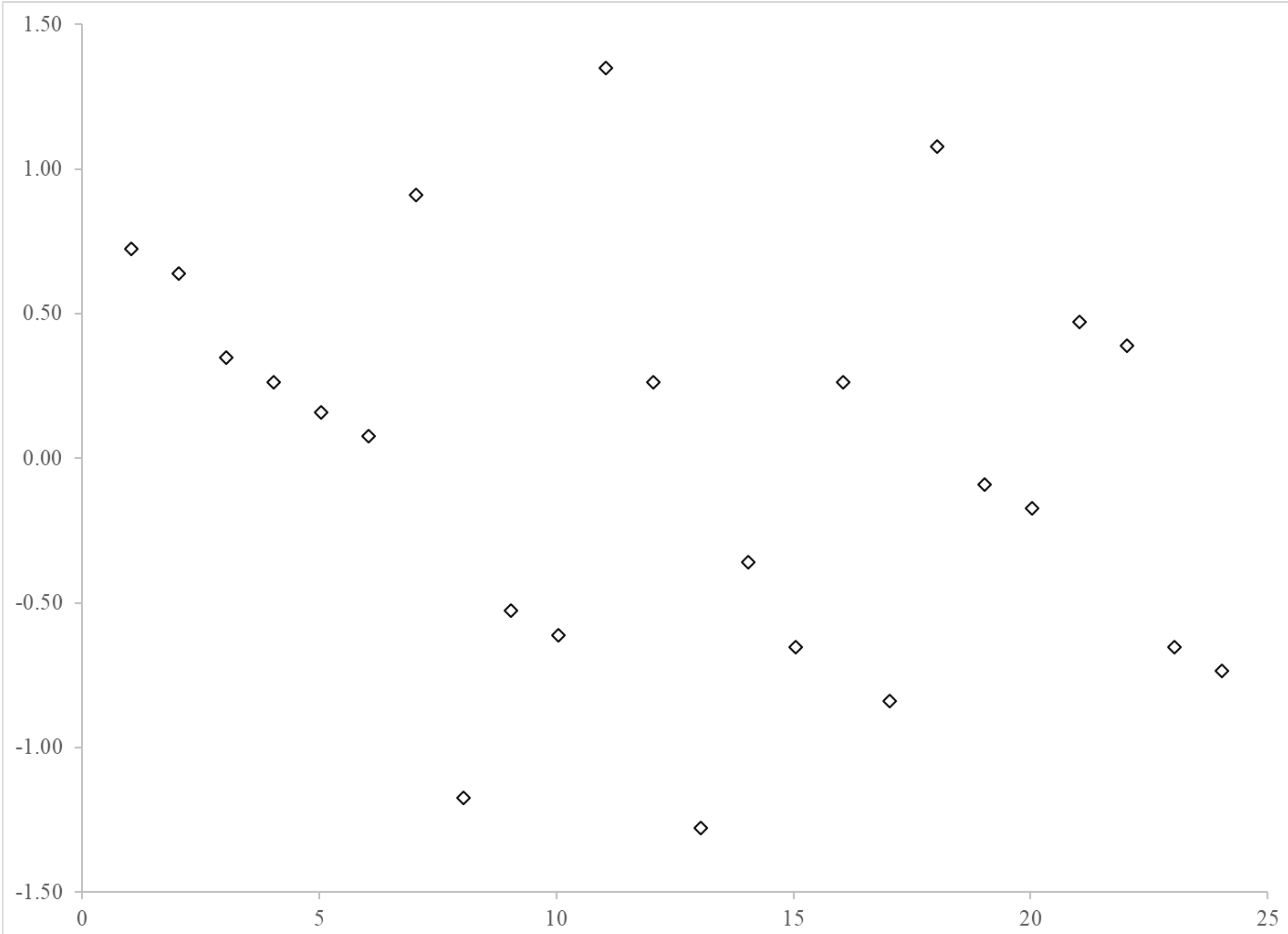

Figure 45: Time series plot of the residuals