
Ideals, Varieties and Algorithms, *fourth edition*

Errata for the fourth edition as of October 5, 2017

Page 23, part (c) of Exercise 5: “Adapt the argument given at the end of the section” should be “Adapt the argument used for the circle $x^2 + y^2 = 1$ ”

Page 24, line 1: “adapt the argument given at the end of the section” should be “adapt the argument used for the circle $x^2 + y^2 = 1$ ”

Page 37, line 2 of part (c) of Exercise 16: “Binomial Theorem” should be “binomial theorem”

Page 39, line 6 of the paragraph beginning “To see why this algorithm works”: “By (5),” should be “By (1),”

Page 47, part (a) of Exercise 14: “where $h(a) \neq 0$ ” should be “where $r \geq 1$ and $h(a) \neq 0$ ”

Page 53, line 2 of Exercise 5: “affine algebraic varieties” should be “affine varieties”

Page 63, bottom display, second line underneath $\overline{\quad}$: “ $xy^2 - x$ ” should be “ $x^2y - x$ ”

Page 63, bottom display, fourth line underneath $\overline{\quad}$: “ $x^2y - y$ ” should be “ $xy^2 - y$ ”

Page 66, lines –5 and –6: “[using condition (ii) of the definition of a monomial order]” should be “[using Lemma 8 of §2]”

Page 81, line 1 of Exercise 2: “ $\text{LT}(I)$ ” should be “ $\langle \text{LT}(I) \rangle$ ”

Page 82, last line of Exercise 13: “Exercise 14 of Chapter 1, §4” should be “Proposition 8 of Chapter 1, §4”

Page 89, part (d) of Exercise 5: “ $z^2 - 3z$ ” should be “ $z^2 - 3z^2$ ”

Page 93, line –3: “ $\langle \text{LT}(G \setminus \{p\}) \rangle$ ” should be “ $\langle \text{LT}(G \setminus \{g\}) \rangle$ ”

Page 96, line 4 of part (b) of Exercise 10: “ $g_j = x_t + D$ ” should be “ $g_j = x_\ell + D$ ”

Page 96, line 4 of part (b) of Exercise 10: “ $S(g_i, g_j) = x_t C - x_s D$ ” should be “ $S(g_i, g_j) = x_\ell C - x_s D$ ”

Page 96, line 2 of part (a) of Exercise 12: “is not divisible by” should be “has leading term not divisible by”

Page 97, line 3 of Exercise 14: “ $\frac{x_j - a_j}{a_i - a_j}$ ” should be “ $\frac{x - a_j}{a_i - a_j}$ ”

Page 105, lines 13–16: Replace $xy + 1$ with $xy - 1$ in three places and $-x - y$ with $-x + y$ in two places. Thus the lines should be as follows:

§3. If we divide $f = xy^2 - x$ by $G = (xy - 1, y^2 - 1)$, the division algorithm gives

$$xy^2 - x = y \cdot (xy - 1) + 0 \cdot (y^2 - 1) + (-x + y)$$

so that $\overline{f}^G = -x + y \neq 0$. Yet we can also write

$$xy^2 - x = 0 \cdot (xy - 1) + x \cdot (y^2 - 1),$$

Page 107, line -4: “ $f_3 = xz + y - z + 1$ ” should be “ $f_3 = xz - x + y + 1$ ”

Page 108, Exercise 1: “ $f_3 = xz + y - z + 1$ ” should be “ $f_3 = xz - x + y + 1$ ”

Page 110, Lemma 4: The statement of the lemma should be changed to the following:

Lemma 4. *Every element of $S(F)$ can be written as a sum of homogeneous elements of $S(F)$. Furthermore, this decomposition is unique.*

Page 115, line 12 “by Lemma 2” should be “by Lemma 2 of §9”

Page 136, line 20: “ $(t, u, x, y, z) \in \mathbf{V}(I) \subseteq \mathbb{R}^5$ ” should be “ $(t, u, x, y, z) \in \mathbf{V}(I) \subseteq \mathbb{C}^5$ ”

Page 140, Exercise 3: “ t^2 is always positive” should be “ t^2 is always ≥ 0 ”

Page 142, part (a) of Exercise 11: In two places, replace F by G

Page 142, part (b) of Exercise 11: Replace F by G

Page 142, line 3 of Exercise 13: “ $x_i = f_i(t)/g_i(t)$ ” should be “ $x_\ell = f_\ell(t)/g_\ell(t)$ ”

Page 142, line 4 of Exercise 13: “each i , $f_i(t)$ and $g_i(t)$ ” should be “each ℓ , $f_\ell(t)$ and $g_\ell(t)$ ”

Page 153, line 1: “straight lines” should be “straight line”

Page 153, line 4: “These lines have” should be “This line has”

Page 154, part (c) of Exercise 15: The x -coordinate of the second displayed point should be

$$\pm \frac{1}{2} \sqrt{15 + 6\sqrt[3]{2} - 12\sqrt[3]{4}}$$

Page 160, part (b) of Exercise 4: “ $g_o = g_3$ ” should be “ $g_o = g_2$ ”

Page 167, line -16: Replace “It follows that” with “(Lemma 3 and Proposition 5 apply to f, g since their coefficients lie in the field $k(x_2, \dots, x_n)$.) It follows that”

Page 169, line -7: “ $u_1(x_1)$ ” should be “ $u(x_1)$ ”

Page 170, line 1: “ $\langle f_i, f_* \rangle$ ” should be “ $\langle f_i, f^* \rangle$ ”

Page 170, part (c) of Exercise 3: “part (a) is still true but part (b) can fail” should be “parts (a) and (b) are still true”

Page 171, line 2 of Exercise 9: “ $l \geq m$ ” should be “ $l \geq m > 0$ ”

Page 180, line 13: “must have $f_i(a_1, \dots, a_n) = 0$ ” should be “must have $f_i(a_1, \dots, a_n) \neq 0$ ”

Page 181, lines 1 and 2 of Exercise 10: “ $\mathbb{R}[x, y]$ ” should be “ $\mathbb{R}[x, y, z]$ ” in two places.

Page 181, line 4 of Exercise 10: “same for $\mathbb{R}[x]$ ” should be “same for $\mathbb{R}[x]$ and $\mathbb{R}[x, y]$ ”

Page 187, line -3: “ $a_1 \frac{\partial f_i}{\partial x_j} h_i$ ” should be “ $a_i \frac{\partial f_i}{\partial x_j} h_i$ ”

Page 189, Exercise 15: Replace the hint with “Hint: Show that xy, xz, yz generate the ideal of leading terms of \sqrt{I} and use the definition of Gröbner basis given in Chapter 1, §5.”

Page 190, line 15: “We have sketched $\mathbf{V}(I)$ and $\mathbf{V}(J)$ on the next page” should be “We have sketched $\mathbf{V}(I)$ and $\mathbf{V}(J)$ below”

Page 196, line 4: “principal ideals is principal)” should be “two principal ideals is principal)”

Page 199, lines 1–2 of **Definition 2**: “smallest affine algebraic variety” should be “smallest affine variety”

Page 201, line 12: “varieties k^n ” should be “varieties in k^n ”

Page 206. Exercise 5: Replace the hint with “Hint: Examine the generators of J^{sM} .”

Page 206, Exercise 7: “and the Exercise 4” should be “and Exercise 4”

Page 212, Exercise 10: “Theorem 10 implies” should be “Theorem 10 and Proposition 6 of §7 imply”

Page 212, line 2 of part (e) of Exercise 13: In “where $(f_1)_{\text{red}}$ is”, there needs to be more space between “(” and “f”.

Page 219, line -18: “is projection” should be “be the projection”

Page 221, line 1: “by Exercise 9 of Chapter 2, §9” should be “by Exercise 15”

Page 221, **Corollary 3**: “With the same notation” should be “With k algebraically closed and the same notation”

Page 222, line 4: “for all i ” should be “for all such i ”

Page 222, line 6: “If follows that” should be “It follows that”

Page 222, line immediately before **Proposition 5**: “what works for V ” should be “that works for V ”

Page 222, line 4 of **Proposition 5**: “ $\pi_l(\mathbf{V}(I^{(i)}))$ ” should be “ $\pi_l(\mathbf{V}(I^{(i)}))$ ”

Page 222, line 5 of **Proposition 5**: “a variety contained in V ” should be “a variety contained in $\mathbf{V}(I_l)$ ”

Page 223, line –17: “ $W \subsetneq \mathbf{V}(I)$ ” should be “ $W \subsetneq \mathbf{V}(I_l)$ ”

Page 223, line –9: “fails for $I, \mathbf{V}(I)\setminus$ ” should be “fails for $I, \mathbf{V}(I_l)\setminus$ ”

Page 223, line –8: “by Proposition 4” should be “by Proposition 4 (we can assume G is reduced)”

Page 224, second display: The display should be as follows:

$$\mathbf{V}(I_1) \setminus \mathbf{V}(c_1) = \mathbb{C} \setminus \mathbf{V}(y) = \mathbb{C} \setminus \{0\} \subseteq \pi_1(\mathbf{V}(I)) \subseteq \mathbf{V}(I_1) = \mathbb{C}.$$

Page 226, two lines below display (2): “ $W_2 \setminus Z_2 \subset \pi_l(V_1)$ ” should be “ $W_2 \setminus Z_2 \subseteq \pi_l(V_1)$ ”

Page 228: Add the following new exercise:

15. In the setting of Theorem 2, prove that $\mathbf{x}^\gamma > \text{LT}(f)$ implies $\mathbf{x}^\gamma > \text{LT}(\bar{f})$ for $f \in k[\mathbf{x}, \mathbf{y}]$.

Page 231, line 9: “**EXERCISES FOR §9**” should be “**EXERCISES FOR §8**”

Page 231, part (b) of Exercise 11: “Exercise 4” should be “Exercise 6”

Page 231, Exercise 12: “Use Proposition 9 of §4” should be “Use Exercise 4 of §4”

Page 232, line 2: “The table on the next page” should be “The table below”

Page 247, line 1: “ $R = k[x, t]$ ” should be “ $R = k[t]$ ”

Page 247, line 2 of part (b) of Exercise 10: “ $a, b \in k[x]$ ” should be “ $a, b \in k$ ”

Page 255, line 6: “goal to find” should be “goal is to find”

Page 255, line 12: “polynomials G_{i-1} ” should be “polynomials in G_{i-1} ”

Page 256, Exercise 6: “Let $V = \mathbf{V}(x_3 - x_1^2, x_4 - x_1x_2, x_2x_4 - x_1x_5, x_4^2 - x_3x_5) \subseteq \mathbb{C}^5$ ” should be “Let $V = \mathbf{V}(I) \subseteq \mathbb{C}^5$ for $I = \langle x_3 - x_1^2, x_4 - x_1x_2, x_2x_4 - x_1x_5, x_4^2 - x_3x_5 \rangle \subseteq \mathbb{C}[x_1, x_2, x_3, x_4, x_5]$ ”

Page 256, line –1: At the end, add “Assume that the field k is infinite.”

Page 257, part (e) of Exercise 11: “we developed in Chapter 1” should be “we developed in Chapter 1, §2”

Page 260, lines 2–4: These three lines

(iii) is proved in the same way as Theorem 11 of Chapter 4, §5. □

When k is algebraically closed, the Weak Nullstellensatz also holds in $k[V]$. You will prove this in Exercise 16.

should be replaced with the following:

(iii) is proved by first showing that the Weak Nullstellensatz also holds in $k[V]$. You will prove this in Exercise 16. From here, one proceeds in the same way as Theorem 11 of Chapter 4, §5. □

Page 271, line following second display: “ $\mathbf{V}_W(a^2 - b^2 + 4)$ ” should be “ $\mathbf{V}_W(y^2 - z^2 + 4)$ ”

Page 272, second paragraph of the proof of **Proposition 6**: In two places, “ $\mathbf{V}(f_i g'_i - f'_i g_i)$ ” should be “ $\mathbf{V}_V(f_i g'_i - f'_i g_i)$ ”

Page 278, line –6: “since we do not the ideal” should be “since we do not want the ideal”

Page 279, display (1): Replace the display with

$$(1) \quad s^\ell + c_1 s^{\ell-1} + \cdots + c_\ell = 0, \quad c_1, \dots, c_\ell \in R.$$

Page 279, line –10: “ $a_{i\ell} s_{i\ell}$ ” should be “ $a_{i\ell} s_\ell$ ”

Page 279, line –7: “the coefficient of x is” should be “the coefficient of x^ℓ is”

Page 279, the last display should be:

$$\det(A - xI_\ell) = (-1)^\ell (x^\ell + c_1 x^{\ell-1} + \cdots + c_\ell).$$

Page 279, line –4: “ $a_i \in R$ ” should be “ $c_i \in R$ ”

Page 280, line –13: “(ii) \Rightarrow (iii)” should be “(i) \Rightarrow (iii)”

Page 280, line –9: “divide f by G ” should be “divide f by a Gröbner basis G ”

Page 282, seven lines below the figure: “the Zariski closure” should be “is the Zariski closure”

Page 282, line –6: “finite over $k[y]$ ” should be “finite over $k[y_1, \dots, y_m]$ ”

Page 284, line 1: “The surprise that” should be “The surprise is that”

Page 284, line 10: “algebraically independently” should be “algebraically independent”

Page 288, line 2 of Exercise 6: “means geometrically” should be “means geometrically when k is algebraically closed”

Page 289, last line of part (a) of Exercise 17: “ $\phi(\mathbf{V}(J))$ ” should be “ $\pi(\mathbf{V}(J))$ ”

Page 291, line 8: The correct hyphenation is “re-searchers”

Page 294, line below second display: “ $C = U \times V$ ” should be “ $\mathcal{C} = U \times V$ ”

Page 298, two lines below third display: The correct hyphenation is “ex-ercises”

Page 300, first display: “ $f(\theta_1 + \theta_2 + \theta_3)$ ” should be “ $f(\theta_1, \theta_2, \theta_3)$ ”

Page 300, paragraph beginning “We will next discuss”: Insert a blank line between the beginning of this paragraph and the end of the previous paragraph.

Page 302, line 2: “ $\mathcal{J} = \mathbf{V}(x_1^2 + y_1^2 - 1, x_2^2 + y_2^2 - 1, x_3^2 + y_3^2 - 1)$ ” should be “ $\mathcal{J} = \mathbf{V}(c_1^2 + s_1^2 - 1, c_2^2 + s_2^2 - 1, c_3^2 + s_3^2 - 1)$ ”

Page 302, two lines below (7): “ $V = \mathbf{V}(x_1^2 + y_1^2 - 1, x_2^2 + y_2^2 - 1, x_3^2 + y_3^2 - 1)$ ” should be “ $V = \mathbf{V}(c_1^2 + s_1^2 - 1, c_2^2 + s_2^2 - 1, c_3^2 + s_3^2 - 1)$ ”

Page 303, Exercise 2: The correct hyphenation is “co-ordinates”

Page 304, part (a) of Exercise 9: “result of part (c)” should be “result of part (e)”

Page 305, line 12: “in equation (7) of §2” should be “in equation (6) of §2”

Page 305, line 1 of (2): “ $\frac{2bl_2l_3}{2l_2(a^2 + b^2)}s_2$ ” should be “ $\frac{bl_2l_3}{l_2(a^2 + b^2)}s_2$ ”

Page 305, line 2 of (2): “ $\frac{2al_2l_3}{2l_2(a^2 + b^2)}s_2 +$ ” should be “ $\frac{al_2l_3}{l_2(a^2 + b^2)}s_2 -$ ”

Page 306, line 1 of (3): “ $\frac{2b}{2(a^2 + b^2)}s_2$ ” should be “ $\frac{b}{a^2 + b^2}s_2$ ”

Page 306, line 2 of (3): “ $\frac{2a}{2(a^2 + b^2)}s_2 +$ ” should be “ $\frac{a}{a^2 + b^2}s_2 -$ ”

Page 307, line -3: “when $a^2 + b^2 < 4$,” should be “when $0 < a^2 + b^2 < 4$,”

Page 308, line 6: “if l_4 lies in” should be “if $l_2 = l_3 = 1$ and l_4 lies in”

Page 308, line 8 of the subsection *Specialization of Gröbner Bases*: “ $k[x_1, \dots, x_m, t_1, \dots, t_m]$ ” should be “ $k[x_1, \dots, x_n, t_1, \dots, t_m]$ ”

Page 309, display in the middle of the page: Replace the display with

$$1, l_2, l_3, l_2, l_3, 1, l_2l_3, l_2l_3, l_2l_3, a, b, a^2 + b^2, l_2l_3.$$

Page 309, two lines below display: “ $a, b, l_2, l_3, a^2 + b^2$ and $a^2 + b^2 - l_2^2 - l_3^2$ are nonzero” should be “ a, b, l_2, l_3 and $a^2 + b^2$ are nonzero”

Page 309, nine lines below display: “concept of a” should be “the concept of a”

Page 309, line –4: “to be Gröbner cover” should be “to be a Gröbner cover”

Page 312, line 3: “We have” should be “When $l_2 = l_3 = 1$, we have”

Page 315, part (c) of Exercise 5: “the choice of $t \in \mathbb{R}$.” should be “the choice of $t \in \mathbb{R}$?”

Page 316, line 5: “ $B_{ij} \in k(\mathbf{t})[\mathbf{x}]$ ” should be “ $B_{ji} \in k(\mathbf{t})[\mathbf{x}]$ ”

Page 316, part (c) of Exercise 7: Replace the hint with “Hint: The monomial orders for $k(\mathbf{t})[\mathbf{x}]$ and $k[\mathbf{x}]$ are the same—the parameters t_j are “constants” as far as the ordering is concerned. Theorem 6 of Chapter 2, §9 will be useful.”

Page 316, lines 7 and 8 of Exercise 8: Delete these lines and replace them with the following:

nonzero polynomials F_i and G_j in $k[\mathbf{t}]$, we get

$$\tilde{f}_i = F_i f_i, \tilde{g}_j = G_j g_j \in k[\mathbf{x}, \mathbf{t}].$$

Page 316, line 9 of Exercise 8: “ $\tilde{I} \subseteq k(\mathbf{t})[\mathbf{x}]$ ” should be “ $\tilde{I} \subseteq k[\mathbf{x}, \mathbf{t}]$ ”

Page 316, part (a) of Exercise 8: Replace part (a) with the following:

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- a. Fix j and suppose $g_j = \sum_{i=1}^s B_{ji} f_i$ in $k(\mathbf{t})[\mathbf{x}]$ and let $d_j \in k[\mathbf{t}]$ be a polynomial that clears the denominators of B_{j1}, \dots, B_{js} . Also let $F = \text{lcm}(F_1, \dots, F_s)$. Then prove that

$$d_j \in (\tilde{I} : F \tilde{g}_j) \cap k[\mathbf{t}],$$

where $\tilde{I} : F \tilde{g}_j$ the ideal quotient as defined in §4 of Chapter 4.

Page 316, part (b) of Exercise 8: “ $(\tilde{I} : \tilde{g}_j) \cap k[\mathbf{t}]$ ” should be “ $(\tilde{I} : F \tilde{g}_j) \cap k[\mathbf{t}]$ ”

Page 316, part (b) of Exercise 8: “to describe an algorithm for finding the subset $W \subseteq k^n$ described in” should be “to give an algorithm for finding a subset $W \subseteq k^n$ with the property described in”

Page 317, line 1: “a monomial on order” should be “a monomial order on”

Page 317, part (b) of Exercise 11: “ $c_i \in \mathbb{R}[a, b, l_2, l_3]$ ” should be “ $h_i \in \mathbb{R}[a, b, l_2, l_3]$ ”

Page 326, line 4 of the first display should be:

$$f_4 = x_3 u_3 + x_4 u_1 - x_4 u_2 - u_1 u_3,$$

Page 327, line 2 of **Definition 7**: “ $\mathbb{R}[u_1, \dots, u_m, x_1, \dots, x_n]$ ” should be “ $\mathbb{R}[u_1, \dots, u_m, x_1, \dots, x_n]$ ”

Page 331, part (b) of Exercise 2: Replace with “b. With this choice, explain why we can specify the coordinates of B as $B = (u_3, 0)$, i.e., the x -coordinate of B is arbitrary, but the y -coordinate is zero.”

Page 332, Exercise 10: “made in Example 1” should be “made in the continuation of Example 1”

Page 332, line –1: “reducible components” should be “irreducible components”

Page 333, line 2 of part (e) of Exercise 14: “follows from part (a)” should be “follows from part (b)”

Page 333, line 2 of part (e) of Exercise 14: “ $(c \cdot g)$ ’s” should be “ $(c \cdot g)^s$ ”

Page 333, line 3 of part (c) of Exercise 15: “show that \bar{c} has” should be “show that $c\bar{c}$ has”

Page 336, lines 6-7: Interchange the order of these two lines. Thus the line “ $q := \dots$ ” should be above the lines “ $r := \dots$ ”

Page 338, line –7: “degree in x_n are reduced” should be “degree in x_n is reduced”

Page 348, line –6: “ $\text{LT}(\sigma_1\sigma)$ ” should be “ $\text{LT}(\sigma_1\sigma_2)$ ”

Page 354, first display of Exercise 11: “ $h_{j-i}(x_k, \dots, x_n)$ ” should be “ $h_{j-i}(x_j, \dots, x_n)$ ”

Page 355, line 1 of the display in Exercise 15: “ $+(-1)^{j-1}\sigma_{k-1}x_i + (-1)^j\sigma_k =$ ” should be “ $+(-1)^{j-1}\sigma_{j-1}x_i + (-1)^j\sigma_j =$ ”

Page 355, line 3 of Exercise 16: “coefficients \mathbb{F}_2 ” should be “coefficients in \mathbb{F}_2 ”

Page 355, display of Exercise 18: “ $= s_j = \sigma_1 s_{j-1} +$ ” should be “ $= s_j - \sigma_1 s_{j-1} +$ ”

Page 356, line 7: “every linear map” should be “every invertible linear map”

Page 361, second display of **Example 13**: Replace with the following:

$$x^i y^j = \begin{cases} x^{2m} y^{2l} = (x^2)^m (y^2)^l & \text{if } i, j \text{ are even} \\ x^{2m+1} y^{2l+1} = (x^2)^m (y^2)^l xy & \text{if } i, j \text{ are odd.} \end{cases}$$

Page 362, Exercise 6: “ $k[x, y, z]^G$ ” should be “ $\mathbb{R}[x, y, z]^G$ ” in part (d) and again in part (e)

Page 362, part (a) of Exercise 7: “ $k[x, y, z]^G$ ” should be “ $\mathbb{R}[x, y, z]^G$ ”

Page 363, second line of the first display: The third factor of g should be “ $(x - y + z)$ ”

Page 363, part (b) of Exercise 7: “ $k[x, y, z]^G$ ” should be “ $\mathbb{R}[x, y, z]^G$ ” twice one line below the display, once two lines below the display, and once three lines below the display

Page 364, part (b) of Exercise 14: “Use the method of Exercise 13” should be “Use the method of Exercise 12”

Page 367, line –1: At the end of the display, “ $\sum_{|\beta|=|G|} R_G(x^\beta)u^\beta$ ” should be “ $\sum_{|\beta|=|G|} b_\beta R_G(x^\beta)u^\beta$ ”

Page 369, line -8: “ $g(y_1, \dots, y_m)$ for some $g \in k[y_1, \dots, y_m]$ ” should be “ $h(y_1, \dots, y_m)$ for some $h \in k[y_1, \dots, y_m]$ ”

Page 369, line -6: “ $+g(y_1, \dots, y_m)$ ” should be “ $+h(y_1, \dots, y_m)$ ”

Page 369, line -5: “ g need not be” should be “ h need not be”

Page 369, line -1: “divide g by G ” should be “divide h by G ”

Page 370, line 1: “ $g = B_1g_1 +$ ” should be “ $h = B_1g_1 +$ ”

Page 370, line 8: “Since G a Gröbner” should be “Since G is a Gröbner”

Page 372, part (b) of Exercise 8: “use Exercise 6 and §2” should be “use Exercise 6 and Example 13 of §2”

Page 375, line 3: “let G be a” should be “let \mathcal{G} be a”

Page 375, line 4: “ $G \cap k[y_1, \dots, y_m]$ ” should be “ $\mathcal{G} \cap k[y_1, \dots, y_m]$ ”

Page 376, line -11: “Gröbner basis G ” should be “Gröbner basis \mathcal{G} ”

Page 376, line -11: “let \bar{g}^G be the” should be “let $\bar{g}^{\mathcal{G}}$ be the”

Page 376, line -10: “on division by G ” should be “on division by \mathcal{G} ”

Page 376, line -10: “the remainders \bar{g}^G ” should be “the remainders $\bar{g}^{\mathcal{G}}$ ”

Page 382, part (c) of Exercise 2: “Use Exercise 13” should be “Use Exercise 16”

Page 382, line 2 of Exercise 9: “ $b = A \cdot \mathbf{a}$ ” should be “ $\mathbf{b} = A \cdot \mathbf{a}$ ”

Page 383, line 2 of Exercise 12: “ $G \cdot \mathbf{b} \cup G \cdot \mathbf{a} - \{\mathbf{a}\}$ ” should be “ $(G \cdot \mathbf{b} \cup G \cdot \mathbf{a}) \setminus \{\mathbf{a}\}$ ”

Page 383, line 6 of Exercise 15: “chapter-then” should be “chapter—then”

Page 383, line 2 of Exercise 16: “as in Definition 1 of” should be “as in Definition 2 of”

Page 385, line -12: “*homogeneous coordinates*. to” should be “*homogeneous coordinates* to”

Page 385, line -12: “treatment of $\mathbb{P}^2(\mathbb{R})$. Our” should be “treatment of $\mathbb{P}^2(\mathbb{R})$. Our”

Page 394, Exercise 7: “the map (2)” should be “the map (1)”

Page 394, part (b) of Exercise 8: “in the from” should be “in the form”

Page 399, line -2: “ $(1 : a_1 : \dots : a_n)$ ” with “ $\phi(a_1, \dots, a_n) = (1 : a_1 : \dots : a_n)$ ”

Page 400, line 16: “in some projective variety” should be “for some projective variety”

Page 404, line 5: “ $1 \leq i_1 <$ ” should be “ $0 \leq i_1 <$ ”

Page 404, line 2 of Exercise 9: “ $f_i \in k[x_0, \dots, x_n]$ ” should be “ $f_j \in k[x_0, \dots, x_n]$ ”

Page 409, line 5: “decomposed to” should be “decomposed into”

Page 410, line -1: “ $k[x_1, \dots, x_n]$ ” should be “ $k[x_0, \dots, x_n]$ ”

Page 413, part (a) of Exercise 3, lines 2 and 3: “ $f = a_1f_1 + \dots + a_sf_s + r$. Prove that the quotients a_1, \dots, a_s ” should be “ $f = q_1f_1 + \dots + q_sf_s + r$. Prove that the quotients q_1, \dots, q_s ”

Page 413, part (a) of Exercise 3, line 3: “remainder r” should be “remainder r ”

Page 414, part (b) of Exercise 13: “ $V \setminus V \cap \mathbf{V}(g)$ ” should be “ $V \setminus (V \cap \mathbf{V}(g))$ ”

Page 416, line 2 of **Lemma 5**: “ $\text{LM}_{>h}(f^h)$ ” should be “ $\text{LM}_{>_h}(f^h)$ ”

Page 416, line -4: “ $\text{LM}_{>h}(f^h)$ ” should be “ $\text{LM}_{>_h}(f^h)$ ”

Page 417, equation (2): “ $\text{LM}_{>h}(f^h)$ ” should be “ $\text{LM}_{>_h}(f^h)$ ”

Page 417, two lines below equation (2): “ $\text{LM}_{>h}(f^h)$ ” should be “ $\text{LM}_{>_h}(f^h)$ ”

Page 419, second sentence of the proof of **Theorem 8**: The sentence should be “Applying the proof of part (i) of Proposition 7 with I in place of $\mathbf{I}_a(W)$ shows that Z is a projective variety containing W .”

Page 423, line 16: “ $\mathbb{P}^1(\mathbb{C}) \times \mathbb{C}$ and you” should be “ $\mathbb{P}^1(\mathbb{C}) \times \mathbb{C}$, and you”

Page 425, first line following fourth display: “trivial solutions $(0:0;y)$ ” should be “trivial solutions $(0, 0, y)$ ”

Page 428, line -11: “Cramer’s Rule” should be “Cramer’s rule”

Page 429, line -1: “This proves $f \in I^{(0)} \cap \dots \cap I^{(n)}$ ” should be “This proves $f \in I_n^{(0)} \cap \dots \cap I_n^{(n)}$ ”

Page 430, line 17: “Now suppose $f \in I^{(i)}$ ” should be “Now suppose $f \in I_n^{(i)}$ ”

Page 430, line 20: “ $f \in I^{(0)} \cap \dots \cap I^{(n)}$ ” should be “ $f \in I_n^{(0)} \cap \dots \cap I_n^{(n)}$ ”

Page 431, line 2 of the proof of **Proposition 8**: “Then the proof of Proposition 7” should be “Then Proposition 7”

Page 432, line 2 after the proof of **Proposition 10**: “ $xy^2 - x + 1$ is a Gröbner basis” should be “ $\{xy^2 - x + 1\}$ is a Gröbner basis”

Page 432, line -1: “point in \mathbb{P}^n ” should be “point in \mathbb{P}^m ”

Page 433, line 1 of the proof of **Theorem 11**: “The first has three parts” should be “The proof has three parts”

Page 433, line -12: “all have weight d ” should be “are all weighted homogeneous of weight d ”

Page 434, line -7: “there is a some” should be “there is some”

Page 443, line below display (9): “ σ suppose that” should be “suppose that”

Page 445, first display: “ $\begin{pmatrix} a_0 & a_1 & a_2 & a_3 \\ b_0 & b_1 & b_1 & b_3 \end{pmatrix}$ ” should be “ $\begin{pmatrix} a_0 & a_1 & a_2 & a_3 \\ b_0 & b_1 & b_2 & b_3 \end{pmatrix}$ ”

Page 446, line 9: “An straightforward” should be “A straightforward”

Page 446, line -3: “ $w_{ij} = \lambda w'_{ij}$ ” should be “ $w'_{ij} = \lambda w_{ij}$ ”

Page 447, line 5: “through two points” should be “through two distinct points”

Page 447, line 10: “are nonzero, and, hence, determine a line L ” should be “are nonzero and distinct, and, hence, determine a unique line L ”

Page 448, part (a) of Exercise 5: “ $\sum_{i,j=0}^n a_{ij}x_i x_j$ ” should be “ $\sum_{i,j=0}^n a_{ij}x_i x_j$ ”

Page 448, line 1 of Exercise 9: “be nonzero” should be “be nonzero with $Q = (a_{ij})$ symmetric”

Page 449, line 3 of Exercise 10: “set of all lines” should be “union of all projective lines”

Page 449, part (a) of Exercise 13: At the end of line 2, add “The image of F is called a *projective line* in \mathbb{P}^n .”

Page 450, line 5: “ $V \subseteq \mathbb{P}^4$ ” should be “ $V \subseteq \mathbb{P}^9$ ”

Page 451, line 1: “lies is $\mathbf{V}(f)$ ” should be “lies in $\mathbf{V}(f)$ ”

Page 451, line 2: “all i ” should be “for all i ”

Page 451, line 4: “ $p =$ ” should be “ $u =$ ”

Page 451, line 5: “ $f(p) = 1$ ” should be “ $f(u) = c_i$ ”

Page 451, line 6: In two places, “ $g(p)$ ” should be “ $g(u)$ ”

Page 453, line -2: “nonzero polynomial” should be “nonconstant polynomial”

Page 454, line 15: “irreducible factors f ” should be “irreducible factors of f ”

Page 456, line 7: “ $f = b_0 z^m + \dots$ ” should be “ $f = a_0 z^m + \dots$ ”

Page 456, line 8: “ $b_0 \in \mathbb{C} \setminus \{0\}$ ” should be “ $a_0 \in \mathbb{C} \setminus \{0\}$ ”

Page 464, part (a) of Exercise 5: “nonzero polynomial” should be “nonconstant polynomial”

Page 472, line 4 of part (b) of Exercise 4: Add “(This is a challenging exercise.)”

Page 481, lines -7 and -6 : “It is easy to generalize this argument and show” should be “By using the discussion following Lemma 4, one can show”

Page 495, part (c) of Exercise 10: “with Theorem 15 of Chapter 4, §3” should be “with Proposition 1 of §1”

Page 495, part (c) of Exercise 13: “Lemma 5 of §2” should be “Lemma 4 of §2”

Page 496, Exercise 7: “ ${}^aHF_I(s) = {}^aHP_I(s)$ ” should be “ ${}^aHF_{R/I}(s) = {}^aHP_{R/I}(s)$ ”

Page 499, line 1: “*an algebraically closed*” should be “*an algebraically closed field*”

Page 505, part (a) of Exercise 11: “ $\phi([f])$ ” should be “ $\phi([f])$ ” (more space between $[$ and f)

Page 505, part (a) of Exercise 11: “ $(f(p_1),$ ” should be “ $(f(p_1),$ ” (more space between $($ and f)

Page 506, part (a) of Exercise 14: “part (a) of the proposition” should be “part (i) of the proposition”

Page 506, part (b) of Exercise 14: “part (b) of the proposition” should be “part (ii) of the proposition”

Page 514, part (a) of Exercise 10: “If $f_1, \dots, f_s \in k[x_1, \dots, x_n]$ ” should be “If $f, f_1, \dots, f_s \in k[x_1, \dots, x_n]$ ”

Page 535, line -1 : “ $k \geq N$ ” should be “ $i \geq N$ ”

Page 536, line 5: “ $W \subset$ ” should be “ $W \subseteq$ ”

Page 536, line 1 of Exercise 13: “ $W \subset$ ” should be “ $W \subseteq$ ”

Page 537, line 4 of part (d) of Exercise 14: “a curve $L \subseteq \Gamma$ ” should be “a curve $\tilde{L} \subseteq \Gamma$ ”

Page 537, hint to part (a) of Exercise 15: “ BL_0V ” should be “ Bl_0V ”

Page 537, part (b) of Exercise 16: “ $q(q, tq) = 0$ ” should be “ $q(tq, q) = 0$ ”

Page 537, part (c) of Exercise 16: “ $q(q, tq) = 0$ ” should be “ $q(tq, q) = 0$ ”

Page 549, part (a) of Exercise 7: “matrix M_3 in (3)” should be “matrix M_3 in (5)”

Page 549, line 2 of part (e) of Exercise 7: The line should be “ $x > y > z$ and explain its relation to the matrix N_2 in Example 8.”

Page 559, line 21: “ $HF_{S/\langle \text{LT}(G) \rangle}(m') < HF_{S/I}(m')$ ” should be “ $HF_{S/\langle \text{LT}(G) \rangle}(m') > HF_{S/I}(m')$ ”

Page 564, line 3: “ $-v^2 + \xi^2 - \zeta^2$ ” should be “ $v^2 - \xi^2 + \zeta^2$ ”

Page 564, line 10: “ $-u\eta^2 + v\zeta^2$ ” should be “ $u\eta^2 - v\zeta^2$ ”

Page 564, line 12: “ $-u\xi^2 + u\zeta^2 + v\eta^2$ ” should be “ $u\xi^2 - u\zeta^2 - v\eta^2$ ”

Page 564, fourth display: “ $-\xi^2\zeta^2 + \eta^4 + \zeta^4$ ” should be “ $\xi^2\zeta^2 - \eta^4 - \zeta^4$ ”

Page 564, sixth display: “ $-xz + y^2 + z^2$ ” should be “ $xz - y^2 - z^2$ ”

Page 570, first display: On the left, “ $\frac{\text{lcm}(\text{LM}(f_i), \text{LM}(f_j))}{\text{LT}(f_j)}$ ” should be “ $\frac{\text{lcm}(\text{LM}(f_i), \text{LM}(f_j))}{\text{LT}(f_i)}$ ”,
(two errors)

Page 578, line 3 of first display: “ xy ” should be “ $-xy$ ”

Page 578, line -1: in two places, “ (xy) ” should be “ $(-xy)$ ”

Page 579, line before last display: “ $-xy + y^2$ ” should be “ $xy + y^2$ ”

Page 582, line 2 of **Example 6**: “ $f_2 = xy^2 - xy$ ” should be “ $f_2 = xy^2 + xy$ ”

Page 582, first display of **Example 6**: “ $-x(xy^2 - xy)$ ” should be “ $-x(xy^2 + xy)$ ”

Page 582, line after first display of **Example 6**: “equal to $\text{LT}(f_1)$ ” should be “equal to $-\text{LT}(f_1)$ ”

Page 582, third display: “ $\mathfrak{s}(\mathbf{g}) = x\mathbf{e}_2$ ” should be “ $\mathfrak{s}(\mathbf{g}) = -x\mathbf{e}_2$ ”

Page 585, line above the second display: “ $y\mathbf{e}_1 - x\mathbf{e}_1$ ” should be “ $y\mathbf{e}_1 - x\mathbf{e}_2$ ”

Page 585, line below the second display: “ $\mathfrak{s}(\mathbf{h}) = x^2\mathbf{e}_2$ divides $\mathfrak{s}(\mathbf{k})$ ” should be “ $\mathfrak{s}(\mathbf{k}) = x^2\mathbf{e}_2$ divides $\mathfrak{s}(\mathbf{h})$ ”

Page 585, line below the second display: “a a” should be “a”

Page 586, first line of pseudocode: “ $f_i \in R$ ” should be “ $f_i \in R, f_i$ monic”

Page 590, part (c) of Exercise 1: On the first line, “order on S ” should be “order on R ”

Page 590, part (c) of Exercise 1: On the second line, “ $>$ ” should be “ $>_{POT}$ ”

Page 590, part (b) of Exercise 2: Replace with “If we allow \mathfrak{s} -reductions and reduction by the syzygy $\mathbf{h} = (-f_2, f_1)$, then show that we can reduce \mathbf{g} to $(0, 0)$.”

Page 590, part (c) of Exercise 2: Replace with “Use Propositions 12 and 14 to explain why the computations in parts (a) and (b) are unnecessary.”

Page 591, line 10 of the pseudocode in Exercise 5: “ $>$ ” should be “ $>_{POT}$ ”

Page 597, line -10: “Cramer’s Rule” should be “Cramer’s rule”