Engineering Dynamics

Jerry H. Ginsberg

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This is the second version of an errata for Engineering Dynamics. Corrections reported here will be incorporated into the second printing of the book. If you find additional corrections, please inform J. H. Ginsberg at jerry.ginsberg@me.gatech.edu. Thank you.

Pg. 15, eq. (1.2.3):

$$\mathrm{F} = \mathrm{ML}/\mathrm{T}^2$$

Pg. 16, eq. (1.2.7):

$$g = 9.807 \text{ m/s}^2$$

Pg. 16, eq. (1.2.8):

$$g = 32.17 \text{ ft/s}^2 \quad \text{or} \quad g = 386.0 \text{ m/s}^2$$

Pg. 31, third line after eq. (2.1.1): ... path. Hence, it is one of the path variables.

Pg. 43, first line: $s'(\beta_P) = 1.1562$. Substitution ...

Pg. 43, first set of equations:

$$\bar{e}_n = 0.6795\bar{i} + 0.5141\bar{j} + 0.0058\bar{k}$$
$$\rho = 1.500 \text{ m}$$

Pg. 43, second set of equations:

$$\bar{a} = 53.88\bar{i} + 22.79\bar{j} + 14.32\bar{k} \text{ m/s}^2$$

Pg. 49, eq. (4): Fix unknown vector:

$$\begin{bmatrix} 0 & 0 & 1 \\ 1 & -10y & 0 \\ x & y & -9z \end{bmatrix} \begin{Bmatrix} \dot{x} \\ \dot{y} \\ \dot{z} \end{Bmatrix} = \begin{Bmatrix} -0.16t \\ 0 \\ 0 \end{Bmatrix}$$

Pg. 61, eq. (2.3.24), fourth line: delete the unit vector $\bar{e}_r$ in the second bracket, that is:

$$= \left[\ddot{r}\bar{e}_r + \dot{r}\left(\dot{\phi}\frac{\partial \bar{e}_r}{\partial \phi} + \dot{\theta}\frac{\partial \bar{e}_r}{\partial \theta}\right)\right] + \left[\dot{r}\dot{\phi}\bar{e}_\phi + r\ddot{\phi}\bar{e}_\phi + r\dot{\phi}\left(\dot{\phi}\frac{\partial \bar{e}_\phi}{\partial \phi} + \dot{\theta}\frac{\partial \bar{e}_\phi}{\partial \theta}\right)\right]$$

Pg. 63, second line from bottom: $F = 38.20$ N,

Pg. 69, eq. (2.3.50):

$$... = h_\alpha \dot{\alpha} \bar{e}_\alpha + ...$$

Pg. 70, eq. (2.3.53): index for the third sum should be μ, that is:

$$... + \sum_{\lambda=\alpha,\beta,\gamma} \sum_{\mu=\alpha,\beta,\gamma} \dot{\lambda}\dot{\mu} \left(\frac{\partial h_\lambda}{\partial \mu} \bar{e}_\lambda + h_\lambda \frac{\partial \bar{e}_\lambda}{\partial \mu} \right)$$

Pg. 72, sixth equation line from bottom: Delete R :

$$\bar{e}_\theta = -\sin(\theta)\,\bar{i} + \cos(\theta)\,\bar{j}$$

Pg. 72, fourth equation line from bottom:

$$\frac{\partial \bar{e}_R}{\partial R} = -\frac{1}{h_\theta}\frac{\partial h_R}{\partial \theta}\bar{e}_\theta - \frac{1}{h_z}\frac{\partial h_R}{\partial z}\bar{e}_z = 0$$

Pg. 73, second equation line from top:

$$\frac{\partial \bar{e}_z}{\partial \theta} = \frac{1}{h_z}\frac{\partial h_\theta}{\partial z}\bar{e}_\theta = 0$$

Pg. 76, Example 2.11, first line: Change "M" to lower case: ... of a mixed kinematical ...

Pg. 88, bottom of page, figure for Exercise 2.45: Label the pivot as A and the upper end of the rotating arm as B.

Pg. 89, Exercise 2.46, second line from bottom: ... values of $\dot{r}$, $\ddot{r}$, $\dot{\lambda}$, $\ddot{\lambda}$, ...

Pg. 104, first line after eq. (3.1.29): ... treated $[R_x]$ and $[R_z]$ as ... (i.e. lower case subscripts)

Pg. 111, first equation:

$$\begin{bmatrix} -0.1059 & -0.1789 & -0.9782 \\ -0.8671 & -1.4980 & -0.0028 \end{bmatrix} \begin{Bmatrix} \ell_{Z'X} \\ \ell_{Z'Y} \\ \ell_{Z'Z} \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$$

Pg. 111, second equation:

$$\begin{bmatrix} -0.8941 & -0.1789 \\ -0.8671 & -1.4980 \end{bmatrix} \begin{Bmatrix} \ell_{Z'X} \\ \ell_{Z'Y} \end{Bmatrix} = \begin{Bmatrix} 0.9782\ell_{Z'Z} \\ 0.0028\ell_{Z'Z} \end{Bmatrix}$$

Pg. 117, last equation in Example 3.5:

$$\begin{Bmatrix} \Delta\bar{r}_B \cdot \bar{I} \\ \Delta\bar{r}_B \cdot \bar{J} \\ \Delta\bar{r}_B \cdot \bar{K} \end{Bmatrix} = [R]_{\mathrm{f}}^{\mathrm{T}} \begin{Bmatrix} 0.2010 \\ -0.3354 \\ 0.6708 \end{Bmatrix} = \begin{Bmatrix} -0.2010 \\ -0.3354 \\ 0.6708 \end{Bmatrix} \text{ m}$$

Pg. 121, second line after eq. (3.3.7): ...defined by Eq. (3.3.7). This ...

Pg. 124, third equation:

$$\left\{ \begin{array}{c} \Delta\bar{r}_B \cdot \bar{I} \\ \Delta\bar{r}_B \cdot \bar{J} \\ \Delta\bar{r}_B \cdot \bar{K} \end{array} \right\} = \left\{ \begin{array}{c} -13.42 \\ 11.16 \\ 0 \end{array} \right\} \text{ mm}$$

Pg. 127, last line: ... general, a specific auxiliary ...

Pg. 138, second equation line from bottom:

$$= \left[-L_2\dot{\theta}^2 \cos\theta - L_2\ddot{\theta}\sin\theta - (L_1 + L_2\cos\theta)\,\Omega^2 \right] \bar{i} + 2L_2\Omega\dot{\theta}\sin\theta\bar{j}$$

Pg. 144, first equation line: Close space:

$$\bar{v}_P = \bar{v}_G + (\bar{v}_P)_{xyz} + \bar{\omega} \times \bar{r}_{P/G}$$

Pg. 146, mid-page, last line of answer for $\bar{v}_P$:

$$= \Omega R\sin\phi\sin\beta\bar{i} + \left(\Omega L\cos\phi\sin\beta + \Omega R\cos\beta - \dot{\phi}R\right)\bar{j} - \Omega L\sin\phi\sin\beta\bar{k}$$

Pg. 148, paragraph following Figure 3.12, line 8: ... radius, $r_e = 6370$ km.

Pg. 148, paragraph following Figure 3.12, line 9: ... rotation is $\omega_e^2 r_e \approx 0.034$ m/s^2

Pg. 149, second line after eq. (3.6.3): ...path is $r_e\cos\lambda$, and ...

Pg. 150, second line above eq. (3.6.8): ...to approximate $\sin(\lambda+\beta) \approx \sin\lambda$ in the ...

Pg. 151, paragraph preceding Example 3.15, second line: ... required by Eqs. (3.6.9), then the ...

Pg. 171, Exercise 3.56. The labels A and B were confused. The problem statement should have been: Airplane A travels eastward at constant speed $v_A = 560$ km/hr, while airplane B executes a constant radius turn, $\rho = 3.2$ km, in the horizontal plane at constant speed $v_B = 1440$ km/hr. At $t = 0$ the angle θ locating airplane B was zero, and s_A at that instant was 5.2 km. Radar equipment on aircraft B can measure ...

Pg. 179, last full line preceding eq. (4.2.7) ... obtained by premultiplication, according ...

Pg. 189, eq. (4.3.11):

$$\bar{v}_A = \bar{v}_B + \bar{\omega}_{AB} \times \bar{r}_{A/B}$$

Pg. 200, eqs. (12): First line is incorrect and lines should be re-aligned:

$$\begin{aligned}
\dot{\theta}_1 &= \dot{\phi}_2 \sin\beta\cos\phi_1, \\
-\dot{\phi}_1 \sin\phi_2\sin\beta &= \dot{\theta}_2, \\
-\dot{\phi}_1 (\cos\phi_1\cos\phi_2 &+ \sin\phi_1\sin\phi_2\cos\beta) \\
&= -\dot{\phi}_2 \left[\cos\beta\left(\cos\phi_1\cos\phi_2 + \sin\phi_1\sin\phi_2\cos\beta\right)\right. \\
&\quad \left. - \sin\beta\left(-\sin\phi_1\sin\phi_2\sin\beta\right)\right] \\
&\equiv -\dot{\phi}_2 \left(\cos\beta\cos\phi_1\cos\phi_2 + \sin\phi_1\sin\phi_2\right).
\end{aligned}$$

$$\bar{v}_A = \bar{v}_B + \bar{\omega}_{AB} \times \bar{r}_{A/B}$$

Pg. 200, answer for $\bar{\omega}$:

$$\bar{\omega} = \dot{\phi}_1 \left[-\bar{I}_1 + \frac{\sin\beta\cos\beta\cos\phi_1}{(\sin\phi_1)^2 + (\cos\beta\cos\phi_1)^2} \left(\cos\phi_1 \bar{J}_1 - \sin\phi_1 \bar{K}_1 \right) \right]$$

Pg. 206, first line after eq. (4.4.17): The angular acceleration is given by the second ...

Pg. 209, first figure: Swap labels C and D, so that the pin is C.

Pg. 219, Exercise 4.13, fourth line: ... and when $\theta = 120^\circ$.

Pg. 230, eq. (5.1.8): symbol in second sum should be $\bar{r}_{j/O}$, that is:

$$\Sigma\bar{F} = \sum_{j=1}^{N} \bar{F}_j = \sum_{j=1}^{N} m_j \frac{d^2}{dt^2}\bar{r}_{j/O} = \frac{d^2}{dt^2}\left(\sum_{j=1}^{N} m_j \bar{r}_{j/O} \right)$$

Pg. 238, first line of last equation: Delete overbar on $\bar{\omega}_1$:

$$\bar{M}_{\text{shaft}} = \frac{d\bar{H}_C}{dt} = \omega_1 \frac{\partial}{\partial\theta}\left[-2mR^2\omega_2 (\sin\theta)(\cos\theta)\,\bar{j}' + 2mR^2\omega_2 (\sin\theta)^2\,\bar{k}' \right]$$

Pg. 241, Figure 5.3, caption: ...relative to a moving xyz ....

Pg. 244, first line above Example 5.2: regardless of its symmetry ...

Pg. 244, third line of Example 5.2 statement: ... to determine $\bar{H}_O$.

Pg. 244, third line of Example 5.2 solution: ... of change of $\bar{H}_O$. The two ...

Pg. 244, third line from bottom of page: To evaluate $\bar{H}_O$ we recall from ...

Pg. 245, first equation, first line: $\bar{H}_O = [2mR^2(-\omega_1)\ldots$

Pg. 245, second, first line: $\bar{H}_O = -2mR^2\omega_1\bar{\imath}' - \ldots$

Pg. 245, change last sentence of Example 5.2: This is the same as the expression that would have been obtained if Example 5.1 had evaluated the moment of momenta relative to point O, rather than point C.

Pg. 253, first paragraph, third line: ... properties of other shapes

Pgs 254-255, text between eq. (5.2.10) and eqs. (5.2.14): The following provides a fully vectorized derivation of the parallel axis theorems that is quite useful for software implementation. It also corrects an error in eqs. (5.2.14), where the subscripts in the second term of each equation should have had a prime:

$$\boxed{\bar{r}_{B/G} = x_B\bar{\imath} + y_B\bar{\jmath} + z_B\bar{k}} \tag{5.2.10}$$

To proceed we invoke an identity for the vector triple product,

$$\bar{a} \times \left(\bar{b} \times \bar{c}\right) \equiv \bar{b}\left(\bar{a}\cdot\bar{c}\right) - \bar{c}\left(\bar{a}\cdot\bar{b}\right),$$

which changes Eq. (5.1.36) to

$$\bar{H}_B = \bar{H}_G + m\left[\left(\bar{r}_{B/G}\cdot\bar{r}_{B/G}\right)\bar{\omega} - \bar{r}_{B/G}\left(\bar{r}_{B/G}\cdot\bar{\omega}\right)\right] \tag{5.2.11a}$$

Let the inertia properties with respect to the parallel coordinate systems xyz and $x'y'z$ be $[I_G]$ and $[I_B]$, respectively. Then the matrix form of the preceding is

$$[I_B]\{\omega\} = [I_G]\{\omega\} + m\left[\left\{r_{B/G}\right\}^{\mathrm{T}}\cdot\left\{r_{B/G}\right\}[U] - \left\{r_{B/G}\right\}\left\{r_{B/G}\right\}^{\mathrm{T}}\right]\{\omega\} \tag{5.2.11b}$$

where $[U]$ is a 3×3 identity matrix and $\left\{r_{B/G}\right\} = [x_B \;\; y_B \;\; z_B]^{\mathrm{T}}$. This relation must apply for any $\{\omega\}$, so the factor of $\{\omega\}$ on each side of the equality must match. The result is the *parallel axis transformation of inertia properties,*

$$\begin{aligned}[I_B] &= [I_G] + m\left[\left\{r_{B/G}\right\}^{\mathrm{T}}\cdot\left\{r_{B/G}\right\}[U] - \left\{r_{B/G}\right\}\left\{r_{B/G}\right\}^{\mathrm{T}}\right] \\ &= [I_G] + m\begin{bmatrix} (y_B^2+z_B^2) & -x_B y_B & -x_B z_B \\ -x_B y_B & (x_B^2+z_B^2) & -y_B z_B \\ -x_B z_B & -y_B z_B & (x_B^2+y_B^2)\end{bmatrix}\end{aligned} \tag{5.2.12}$$

The first form is useful for computer applications, while using the second form to match like elements yields the scalar transformations. The diagonal terms govern the moments of inertia,

$$\boxed{\begin{aligned} I_{x'x'} &= I_{xx} + m\,(y_B^2+z_B^2) \\ I_{y'y'} &= I_{yy} + m\,(x_B^2+z_B^2) \\ I_{z'z'} &= I_{zz} + m\,(x_B^2+y_B^2)\end{aligned}} \tag{5.2.13}$$

while the off-diagonal terms transform the products of inertia,

$$\boxed{\begin{aligned} I_{x'y'} &= I_{yx} = I_{xy} + m x_B y_B \\ I_{x'z'} &= I_{zx} = I_{xz} + m x_B z_B \\ I_{y'z'} &= I_{zy} = I_{yz} + m y_B z_B\end{aligned}} \tag{5.2.14}$$

Pg. 264, second line of Example 5.7: ... parallel to the orthogonal edges and ...

Pg. 268, eq. (5.2.34), subscript for $\{e_3\}$:

$$\begin{bmatrix} I_1 & 0 & 0 \\ 0 & I_2 & 0 \\ 0 & 0 & I_3\end{bmatrix} = \begin{bmatrix}\{e_1\}^{\mathrm{T}} \\ \{e_2\}^{\mathrm{T}} \\ \{e_3\}^{\mathrm{T}}\end{bmatrix}[I]\left[\;\{e_1\}\;\;\{e_2\}\;\;\{e_3\}\;\right]$$

Pg. 275, eq. (5.3.1): Remove box highlighting the equation.

Pg. 276, eq. (5.3.4): the overdot above the first occurrence of $\bar{H}_A$ needs to be centered.

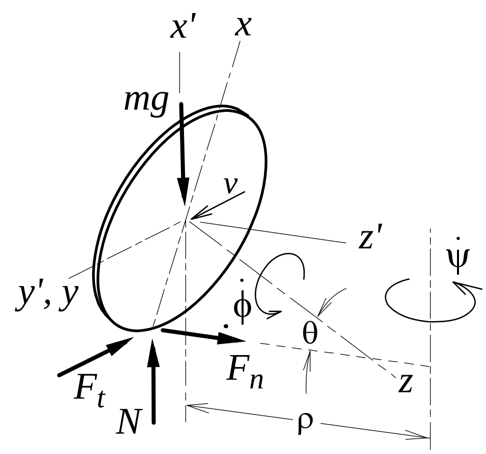
Pg. 280, first equation: the overdot above $\bar{H}_A$ needs to be centered.

Pg. 297, first paragraph: fifth and sixth lines: ... the angular momentum requires application of the required moment. The same is true for linear momentum. The ...

Pg. 307, top of page: fix answers for $\bar{j}$ and $\bar{k}$ components of $\bar{M}_A$:

$$
\begin{aligned}
\Sigma \bar{M}_A \cdot \bar{j} \ &= mg\left(L \sin\theta\right) = I_{yy}\alpha_y - \left(I_{zz} - I_{xx}\right)\omega_x\omega_z \\
&= m\left(\frac{1}{4}R^2 + L^2\right)\left(-\ddot{\theta} - \dot{\phi}\Omega\sin\theta\right) \\
&\quad + m\left(\frac{1}{4}R^2 - L^2\right)\left(-\dot{\phi} - \Omega\cos\theta\right)\left(\Omega\sin\theta\right) \\
\Sigma \bar{M}_A \cdot \bar{k} \ &= M\sin\theta + M_{x'}\cos\theta = I_{zz}\alpha_z - \left(I_{xx} - I_{yy}\right)\omega_x\omega y \\
&= m\left(\frac{1}{4}R^2 + L^2\right)\left(-\acute{\dot{\phi}}\dot{\theta} + \dot{\theta}\Omega\cos\theta\right) \\
&\quad - m\left(\frac{1}{4}R^2 - L^2\right)\left(-\dot{\phi} - \Omega\cos\theta\right)\left(-\dot{\theta}\right)
\end{aligned}
$$

Pg. 312, second figure: Insert label G at center and show x axis = horizontal diameter and y axis = vertical diameter:



Free body diagram of the rolling disk

Pg. 314, paragraph following first set of equations, first line: ... unknown, so the moment

Pg. 317, line following second equation: ... to xyz, so we need to express $\bar{\imath}$ in terms ...

Pg. 318, first equation: Change ϕ to θ in first line and change sign in third line:

$$
\begin{aligned}
\dot{\bar{H}}_A \ &= \left\{-I_{xx}\ddot{\phi} + \left[\left(I_{yy} - I_{zz}\right)\sin\phi\cos\phi\left(\sin\theta\right)^2 + I_{xz}\sin\phi\sin\theta\cos\theta\right]\dot{\psi}^2\right\}\bar{\imath} \\
&\quad + \left\{\left[\left(I_{xx} - I_{yy}\right)\cos\phi\sin\theta\cos\theta + I_{xz}\left(\left(\cos\theta\right)^2 - \left(\cos\phi\right)^2\left(\sin\theta\right)^2\right)\right]\psi^2\right. \\
&\quad \left. + \left[\left(I_{xx} + I_{yy} - I_{zz}\right)\cos\phi\sin\theta + 2I_{xz}\cos\theta\right]\psi\dot{\phi} + I_{xz}\dot{\phi}^2\right\}\bar{\jmath} \\
&\quad + \left\{I_{xz}\ddot{\phi} + \left[\left(I_{xx} - I_{yy}\right)\sin\phi\sin\theta\cos\theta - I_{xz}\sin\phi\cos\phi\left(\sin\theta\right)^2\right]\psi^2\right. \\
&\quad \left. + \left[\left(I_{xx} - I_{yy} + I_{zz}\right)\sin\phi\sin\theta\right]\psi\dot{\phi}\right\}\bar{k}
\end{aligned}
$$

Pg. 318, last equation:

$$\{mg\} = mg\,[R]\left\{\begin{array}{c} 0 \\ \sin\psi \\ -\cos\psi \end{array}\right\} = ...$$

Pg. 320, eq. (6.2.3), second line:

$$\Sigma\bar{M}_A \cdot \bar{j} = -I_{yz}\dot{\omega} - I_{xz}\omega^2$$

Pg. 325, first paragraph, second line: ... of the box has no obvious ...

Pg. 329, eqs. (4), third line:

$$\Sigma\bar{M}_G \cdot \bar{k} = F\left(\frac{L}{2}\sin\theta\right) + N_A\left(\frac{L}{2}\cos\theta\right) - ....$$

Pg. 337, eqs. (10), first line: Insert comma before N_2 to separate equations.

Pg. 339, third paragraph. second line: ... of such forces are those generated ...

Pg. 339, third paragraph. fifth to fourth lines preceding eq. (6.4.2):... instantly from time t_i^- to time t_i^+, while the ...

Pg. 345, eq. (6.4.16), both path integral symbols should have "C" rather than "o":

$$\boxed{W_{1\to 2} = \oint_1^2 \Sigma\bar{F} \cdot d\bar{r}_B + \oint_1^2 \Sigma\bar{M}_B \cdot \overline{d\theta}}$$

Pg. 345, eq. (6.4.17):

$$W_{1\to 2} = -W_{2\to 1}$$

Pg. 346, Eq. (6.4.20): Path integral should have "C" rather than "o":

$$W_{1\to 2} = \oint_1^2 \left(-mg\bar{K}\right) \cdot \left(dX\bar{I} + dY\bar{J} + dZ\bar{K}\right) = \ ...$$

Pg. 347, Eq. (6.4.23), first line: The path integral should have "C" rather than "o", that is:

$$W_{1\to 2} = \oint_1^2 \left(-\frac{GmM}{r^2}\bar{e}_r\right) \cdot \left(dr\bar{e}_r + rd\phi\bar{e}_\phi + rd\theta\sin\phi\bar{e}_\theta\right) \ ...$$

Pg. 348, eq. (6.4.34): The path integral should have "C" rather than "o", that is

$$\frac{1}{2}m\left(v_G^2\right)_2 = \frac{1}{2}m\left(v_G^2\right)_1 + \oint_1^2 \Sigma\bar{F} \cdot d\bar{r}_G$$

Pg. 350, eq. (6.4.39), delete the path integral symbol:

$$\mathcal{P}^{\rm nc} = \sum_{j=1}^{N} \bar{F}_j^{\rm nc} \cdot \bar{v}_j = \Sigma\bar{F}^{\rm nc} \cdot \bar{v}_B + \Sigma\bar{M}_B^{\rm nc} \cdot \bar{\omega}$$

Pg. 353, fifth line after figure: ... diagram exert any moment about ...

Pg. 353, first line after eq. (1): The angular velocity of these bodies is the sum of the ...

Pg. 358, fourth equation from top of page, second line: Insert 10^3 factor preceding rad/s:

$$= [-17.920321 \quad 23.868431 \quad 40000]^{\mathrm{T}} \left(10^3\right) \text{ rad/s}$$

Pg. 359, fourth line from bottom of page: Delete clause at end of first sentence: ... to change simultaneously. This is a fundamental ...

Pg. 362, third paragraph, replace sentence preceding eq. (6.4.44): ... in Eqs. (6.4.40). Also, because the centers of mass and the contact point lie in the xy plane for planar motion, only the $\bar{k}$ components of the cross products of the moments of $\bar{F}$ about points A and B are required. They are given by

Pg. 362, eq. (6.4.44): Delete condition for equation to apply, that is:

$$\bar{k} \cdot \left(\bar{r} \times F\bar{i}\right) \equiv F\bar{r} \cdot \left(\bar{\imath} \times \bar{k}\right) = -F\bar{r} \cdot \bar{j}$$

Pg. 363, first line after eq. (6.4.50): In view of Eq. (6.4.42), the velocity ...

Pg. 365, eq. (6.4.53): Insert unit vector $\bar{\imath}$ after F, that is:

$$\bar{f} = -\mu_k F\bar{i} \frac{\left(\bar{v}_{CA}\right)_0 \cdot \bar{i} - \left(\bar{v}_{CB}\right)_0 \cdot \bar{i}}{\left|\left(\bar{v}_{CA}\right)_0 \cdot \bar{i} - \left(\bar{v}_{CB}\right)_0 \cdot \bar{i}\right|}$$

Pg. 395, last line: "the" is repeated.

Pg. 404, second line preceding Figure 7.6: .. then $a_{13}g_1 = 0 = \partial f_1/\partial\theta$. This ...

Pg. 406, Solution to Example 7.2, fifth line: ... we define $q_1 = X_B$, $q_2 = Y_B$, ...

Pg. 411, first paragraph after Figure 7.9, fifth line: ... is tangent to the constraint surface at the instant ...

Pg. 420, eq. (7.3.8), first line: All subscripts "P" should be capitalized.

Pg. 420, first paragraph following indented text in italics, fourth line: ... ... $+ r\dot{\theta}\sin\phi\bar{e}_\theta$. There is no $\bar{v}_{Pt}$ term ...

Pg. 427, second line after eq. (7.4.6): ... couples allows us to collect ...

Pg. 434, Figure 7.10 (a): Change θ label to ϕ.

Pg. 438, seventh line after second figure: Delete second $\bar{i}$: ... we have $\bar{f} = -f\,\bar{i}$, with $f = \mu_k N \operatorname{sgn}\left(\bar{v}_C \cdot \bar{i}\right)$. As we ...

Pg. 443, fourth text line from bottom of page: ... to δW of $\bar{F}$ proceeds in ...

Pg. 443, last text line: ... $R_j^{(1)}$ in Eqs. (7) gives

Pg. 445, Example 7.12, fourth line of problem statement: ... corresponding to θ being the ...

Pg. 447, second line after eq. (7.5.3): ... partial derivatives $\partial \bar{r}_n / \partial q_j$ depend ... (that is, delete the dot above q_j).

Pg. 452, midpage, line preceding equation for δW : ... θ by $\delta\theta$, so the virtual work is

Pg. 460, fifth line of equation for $\frac{d}{d}\left(\frac{\partial T}{\partial \dot{\theta}}\right)$ at bottom of page: Insert overdot above θ :

$$... + (m_A + m_r)\,\varepsilon\,(\sin\theta)\,\dot{x}\dot{\theta}$$

Pg. 460, second equation line from bottom of page:

$$\frac{\partial T}{\partial \theta} = -\left[(m_A + m_r)\,\varepsilon^2\,(\cos\theta\sin\theta) + m_r R\varepsilon\sin\theta\right]\dot{\theta}^2 + ...$$

Pg. 462, equation for V at midpage:

$$V = mgL\cos\theta$$

Pg. 462, second equation from bottom of page:

$$\frac{\partial V}{\partial \theta} = -mgL\sin\theta$$

Pg. 462, last equation:

$$\left(I_2 + mL^2\right)\ddot{\theta} - \left(I_2 + mL^2 - I_1\right)\sin\theta\cos\theta - \left(mgL + I_1\dot{\psi}\dot{\phi}\right)\sin\theta = 0$$

Pg. 465, first equation first line: Delete subscript from T

Pg. 465, eq. (7), second line:

$$+\frac{1}{2}\left[I_2' + I_3' + I_1'(\sin\phi)^2\right]\dot{\theta}^2 + \frac{1}{2}I_1'\dot{\phi}^2 - ...$$

Pg. 466, first equation:

$$\begin{aligned}
\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{\theta}}\right) &= \frac{d}{dt}\left\{\left[I_2' + I_3' + I_1'(\sin\phi)^2\right]\dot{\theta} - \frac{1}{2}I_1'\dot{\psi}(\sin\theta)(\sin 2\phi)\right\} \\
&= \left[I_2' + I_3' + I_1'(\sin\phi)^2\right]\ddot{\theta} - \left[\frac{1}{2}I_1'(\sin\theta)(\sin 2\phi)\right]\ddot{\psi} \\
&\quad + \left[I_1'(\sin 2\phi)\right]\dot{\theta}\dot{\phi} - \frac{1}{2}\left[I_1'(\cos\theta)(\sin 2\phi)\right]\dot{\psi}\dot{\theta} \\
&\quad - \left[I_1'(\sin\theta)(\cos 2\phi)\right]\dot{\psi}\dot{\phi}
\end{aligned}$$

Pg. 468, eq. (7.6.6): Insert 1/2 factor in second line after second equal sign:

$$\begin{aligned}
\frac{\partial T_2}{\partial \dot{q}_s} &= \frac{1}{2}\sum_j\sum_n M_{jn}\frac{\partial}{\partial \dot{q}_s}(\dot{q}_j\dot{q}_n) = \frac{1}{2}\sum_j\sum_n M_{jn}(\delta_{sj}\dot{q}_n + \dot{q}_j\delta_{sn}) \\
&= \frac{1}{2}\sum_n M_{sn}\dot{q}_n + \frac{1}{2}\sum_j M_{js}\dot{q}_j = \frac{1}{2}\sum_n (M_{sn} + M_{ns})\,\dot{q}_n = \sum_n M_{sn}\dot{q}_n
\end{aligned}$$

Pg. 475, figure at top of page: Fix legend: solid line is x, dashed line is x_r, dot-dash line is x_A

Pg. 481, Exercise 7.24, last line: $(k/m)^{1/2} = 20$ rad/s, ...

Pg. 497, sixth line: ... on the motion is $\dot{\psi} = b\theta^2$,

Pg. 498, second equation line from bottom: Insert H after g :

$$... - \left(\frac{1}{2}m_1 + m_2\right) gH \sin\psi$$

Pg. 505, eq. (3):

$$\bar{v}_C = \dot{X}\bar{I} + \dot{Y}\bar{J} + \dot{Z}\bar{K}$$

Pg. 505, set of eqations above eqs. (4):

$$\begin{aligned} \bar{i} &= \cos\theta\left(\cos\psi\bar{I} + \sin\psi\bar{J}\right) - \sin\theta\bar{K} \\ \bar{j} &= -\sin\psi\bar{I} + \cos\psi\bar{J} \\ \bar{k} &= \sin\theta\left(\cos\psi\bar{I} + \sin\psi\right)\bar{J} + \cos\theta\bar{K} \end{aligned}$$

Pg. 509, eq. (8.2.3):

$$\frac{d}{dt}\{z\} = \{G(z_i, t)\}$$

Pg. 516, first line after eq. (8.2.40): In view of Eq. (8.2.39), the result ...

Pg. 522, first full line above eq. (8.2.61): .. nonholonomic equations. Thus the .....

Pg. 533, eq. 6: Change G to lower case...

Pg. 533, last line: $\{q\} = [0\ \ 0\ \ 0\ \ \pi/2 - 0.01\ \ 0]^{\mathrm{T}}$, $\{\dot{q}\} = ...$

Pg. 534, fourth line above figures: ... the initial value $\pi/2 - 0.010$.) We also ...

Pg. 535, second line after figure: puter models that do ...

Pg. 539, first equation after eqs. (4):

$$\bar{v}_B = \frac{d}{dt}\bar{r}_{B/O} = ...$$

Pg. 563, last equation: First term on right side needs a dx factor:

$$\int_{t_0}^{t_1} \delta T dt \ = \mu \int_0^L \left[(\dot{w} + vw')\,\delta w\right]\Big|_{t=t_0}^{t=t_1} dx + ...$$

Pg. 569, equation for V at bottom of page: Deleted exponent 2 inside integrand on first line:

Pg. 570, fourth equation line from bottom of page:

$$\frac{\mu L}{2}\ddot{q}_n + \left(\frac{F - \mu v^2}{L}\right)\left(\frac{n^2\pi^2}{2}\right) q_n + \mu v \sum_{j=1}^{N} B_{jn}\dot{q}_j ...$$

Pg. 570, second equation line from bottom of page:

$$\frac{\mu L}{2}\ddot{q}_n - \mu v \sum_{k=1}^{N} G_{nk}\dot{q}_k + \left(\frac{F-\mu v^2}{L}\right)\left(\frac{n^2\pi^2}{2}\right) q_n = ...$$

Pg. 575, first full line above Example 9.3: ... done numerically by solving $[M]\{q\} = \{F\}$ at ...

Pg. 584, eq. (9.2.29), first line:

$$\frac{\partial \mathcal{L}}{\partial \dot{q}_n} = p_n \text{ for } n = K+1, ..., N \text{ yields}$$

Pg. 585, eq. (9.2.34):

$$\boxed{\frac{d}{dt}\left(\frac{\partial \Re}{\partial \dot{q}_j}\right) - \frac{\partial \Re}{\partial q_j} = Q_j, \quad j = 1, .., K}$$

Pg. 586, first paragraph, third line: ... so the slope $Z' \equiv dZ/dR$, so that

Pg. 586, second paragraph, third line: ... axis and Ω_y about the y axis. Therefore, ...

Pg. 586, third equation from bottom of page:

$$\Omega_y = \frac{\dot{R}}{\sigma \cos\beta}$$

Pg. 587, second equation: Change σ^2 to σR in last term on second line

$$\begin{aligned} 2T = \; & \frac{7}{5}m\left(\frac{\dot{R}}{\cos\beta}\right)^2 + m\left[\frac{7}{5}R^2 + \frac{2}{5}\sigma^2(\cos\beta)^2\right]\dot{\theta}^2 \\ & + \left[\frac{2}{5}m(R+\sigma\sin\beta)^2 + I\right]\dot{\psi}^2 - \frac{4}{5}\left(R^2 + \sigma R\sin\beta\right)\dot{\theta}\dot{\psi} \end{aligned}$$

Pg. 592, second line after eq. (9.3.9): ... must be suitably selected if the virtual displacement is to be kinematicallly admissible. ...

Pg. 593, first line: ... are $q_1 = X_B$, $q_2 = Y_B$, and ...

Pg. 595, first line: ... form in Eq. (9.3.9). We ...

Pg. 604, eq. (4):

$$\bar{a}_G = \bar{a}_C + \left(\ddot{\gamma}_2\bar{k}\right) \times \bar{r}_{G/C} - \dot{\gamma}_2^2\bar{r}_{G/C} = ...$$

Pg. 607, second paragraph, third line: ... other forces of concern are the normal force exerted on the collar and the spring force. We ...

Pg. 608, eq. (8), first line: Insert a prime after $\bar{j}$:

$$\bar{\alpha}_{\text{wheel}} = \left(-\frac{\ddot{\gamma}_2}{R}\frac{\cos\theta}{\cos\beta} + \frac{\dot{\gamma}_1\dot{\gamma}_2}{R}\frac{\sin\theta}{\cos\beta} - \frac{\dot{\gamma}_2\dot{\beta}}{R}\frac{\cos\theta\sin\beta}{(\cos\beta)^2}\right)\bar{j}'$$

Pg. 610, first paragraph, line following second equation on the page: ... required to convert derivatives of V to generalized forces are ...

Pg. 610, second paragraph, line following equation for $\bar{v}_B$: ... changing each $\dot{\gamma} dt$ to $\delta\gamma$ ...

Pg. 611, line after eq. (10): The second Gibbs-Appell equation, $\partial S/\partial\ddot{\gamma}_2 = \Gamma_2$, is

Pg. 637, third line from top: ... a specified motion. In other situations the response ...

Pg. 639, paragraph following eq. (10.1.8), fifth line: ... is such that $\theta > \beta$ and $\acute{\phi}$ has the same sign as ω. (Cases ...

Pg. 641, eq. (2):

$$\beta = \tan^{-1}\left(\frac{I}{I'}\tan\theta\right) = 10.68^\circ$$

Pg. 642, first equation:

$$\bar{\omega} = \omega\left(\sin\beta\bar{j} - \cos\beta\bar{k}\right) = \omega\left(0.18526\bar{j} - 0.9827\bar{k}\right)$$

Pg. 643, eq. (10.1.10), first line:

$$\bar{K} = -\sin\theta\cos\phi\bar{i} + \sin\theta\sin\phi\bar{j} + \cos\theta\bar{k}$$

Pg. 643, eq. (10.1.11), second line:

$$+\left(\dot{\psi}\cos\theta + \dot{\phi}\right)\bar{k}$$

Pg. 643, eq. (10.1.12), first and third lines: $\bar{k}$ components should have $\cos\theta$, rather than $\cos\phi$, that is

$$\begin{aligned} \bar{H}_G &= H_G\bar{K} = H_G\left(-\sin\theta\cos\phi\bar{i} + \sin\theta\sin\phi\bar{j} + \cos\theta\bar{k}\right) \\ &= I_1\left(-\dot{\psi}\sin\theta\cos\phi + \dot{\theta}\sin\phi\right)\bar{i} + I_2\left(\dot{\psi}\sin\theta\sin\phi + \dot{\theta}\cos\phi\right)\bar{j} \\ &\quad +I_3\left(\dot{\psi}\cos\theta + \dot{\phi}\right)\bar{k} \end{aligned}$$

Pg. 643, equation at bottom of the page:

$$H_G = \left[I_1^2\left(\omega_x\right)_0^2 + I_2^2\left(\omega_y\right)_0^2 + I_3^2\left(\omega_z\right)_0^2\right]^{1/2}$$

Pg. 644, eq. (10.1.14), third line:

$$I_3\left(\dot{\psi}\cos\theta + \dot{\phi}\right) = H_G\cos\theta$$

Pg. 645, first paragraph, sixth line: ... equations are identically satisfied ...

Pg. 645, first paragraph, seventh line: ... and $\dot{\phi} = H_G/I_3$. Thus ...

Pg. 645, eqs. (10.1.17), third line:

$$I_3\left[\left(\varepsilon\dot{\xi}_1\right)\cos\theta+\left(\Omega+\varepsilon\dot{\xi}_3\right)\right]=H_G\cos\theta$$

Pg. 656, second paragraph of Section 10.2, second line: nents A_j in orthogonal directions. ...

Pg. 657, Figure 10.7: Origin of XYZ should be labeled as O.

Pg. 659, third paragraph, sixth line: ... equivalently the smallest nutation angle. Similarly, ...

Pg. 663, eq. (10.2.23):

$$2\dot{u}\ddot{u}=\frac{df}{du}\dot{u}=....$$

Pg. 664, first line after eq. (10.2.29): ... results is that the precession rate ...

Pg. 669, eq. (4), first line

$$\bar{M}=\Gamma\sin\theta\left\{\sin\left(2\Omega t-2\psi\right)\bar{i}-\cos\theta\left[1+\cos\left(2\Omega t-2\psi\right)\right]\bar{j}\right\}$$

Pg. 675, eq. (2), second line:

$$g\left(\dot{\psi},\theta\right)=\left(\frac{I}{I'}-1\right)\dot{\psi}^2\sin\theta\cos\theta+\left(\frac{I}{I'}\dot{\psi}\dot{\phi}-\frac{\gamma}{2}\right)\sin\theta$$

Pg. 676, eq. (3):

$$g\left(\dot{\psi}^*,\theta^*\right)=$$

Pg. 676, eq. (4):

$$\left(\frac{I}{I'}-1\right)\left(\dot{\psi}^*\right)^2\cos\theta^*+\frac{I}{I'}\dot{\psi}^*\dot{\phi}-\frac{\gamma}{2}=0$$

NOTE: A corrected list of answers is contained in a separate file: *Answers List-version 2.pdf.*