Errata 10th Edition, Dynamics for Engineering Practice

Page

9 $V_{\max} = 5 + 5(3.33)^2 - 3.33^3$

11 $v_X = \dot{r}_X = -b\omega\, sin\omega t \quad m/\mathrm{sec}\ , \quad v_Y = \dot{r}_Y = b\omega\, cos\omega t \quad m/\mathrm{sec},$

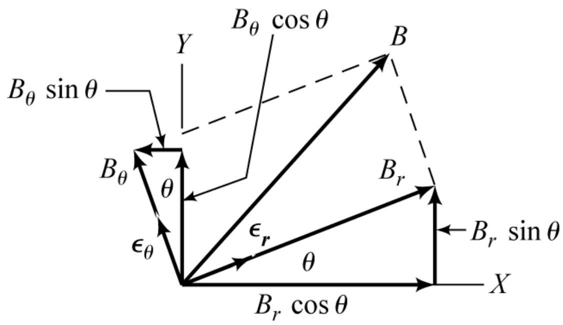
15

$$\ddot{\boldsymbol{r}} = \ddot{r}\boldsymbol{\varepsilon}_r + \dot{r}\dot{\theta}\boldsymbol{\varepsilon}_\theta + (\dot{r}\dot{\theta} + r\ddot{\theta})\boldsymbol{\varepsilon}_\theta - r\dot{\theta}^2\boldsymbol{\varepsilon}_r$$

$$= (\ddot{r} - r\dot{\theta}^2)\boldsymbol{\varepsilon}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\boldsymbol{\varepsilon}_\theta \qquad \textbf{(2.30)}$$

$$= a_r\,\boldsymbol{\varepsilon}_r + a_\theta\,\boldsymbol{\varepsilon}_\theta\ .$$

16



19 2nd column, 9 lines down: Hence, $\boldsymbol{v} = \boldsymbol{\varepsilon}_t\, 20\ m/\mathrm{sec}$.

24 1st column, units

$$a_r = \ddot{r} - r\dot{\theta}^2 = -394.8 - 12.5\times(-2.467)^2 = -470.9\,mm/\mathrm{sec}^2\ .$$

25 1st column

$$Y' = \frac{dY}{dX} = \frac{2A\pi}{L}\cos\left(\frac{2\pi X}{L}\right) = \frac{2\times 100\pi}{2000}\times\cos\left(\frac{2\pi 750}{2000}\right) = -.222 \ \Rightarrow\ \beta = \tan^{-1}(-.222) = -12.52°\ .$$

1st column, bottom, denominator

$$\frac{1}{\rho} = \frac{|Y''|}{[1+(Y')^2]^{3/2}} = \frac{6.98\times 10^{-4}}{[1+(-.222)^2]^{3/2}} = 6.49\times 10^{-4} m^{-1} \ \Rightarrow\ \rho = 1540\,m\ ,$$

31

$$\dot{\boldsymbol{\omega}} = \hat{\dot{\boldsymbol{\omega}}}\ . \qquad \textbf{(2.72)}$$

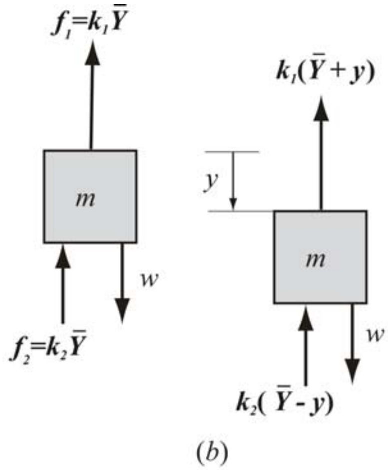
46

$$m\,\dot{Y}(t) - m\,\dot{Y}_0 = \int_0^t (-w)\,d\tau\ .$$

48

$$m\ddot{y} = \sum f_y = w - k_1(\bar{Y}+y) - k_2(\bar{Y}-y) = w - (k_1+k_2)\bar{Y} - (k_1+k_2)y = 0 - (k_1+k_2)y$$
$$\therefore\ m\ddot{y} + (k_1+k_2)y = 0\ .$$

49 Fig. 3.6(b)



51 Caption, figure 3.7: $Y(t)$ with $k = 5.865\times10^6$; also second line, right column, $k = 5.865\times10^6$

53 Proceeding to a time solution for $m\ddot{Y} + c\dot{Y} + kY = w$ ...

54

$$\dot{Y} = e^{-\zeta\omega_n t}\ \omega_d\ (-A\ \sin\omega_d t\ +\ B\ \cos\omega_d t) - \zeta\omega_n\ e^{-\zeta\omega_n t}(A\ \cos\omega_d t\ +\ B\ \sin\omega_d t)\ .$$

56

$$x\ =\ x_h\ =\ e^{-\zeta\omega_n t}\ (A\ \cos\omega_d t\ +\ B\ \sin\omega_d t)\ , \qquad \textbf{(i)}$$

59

$$\zeta = \frac{\delta}{[(2\pi)^2 + \delta^2]^{1/2}} = \frac{0.597}{\sqrt{4\pi^2 + .597^2}} = 0.095$$

60

$$m\ddot{Y} = \Sigma f_Y = -w - c(\dot{Y} - \dot{Y}_b) - k(Y - Y_b)$$
$$\therefore\ m\ddot{Y} + c\dot{Y} + kY = -w + kY_b + c\dot{Y}_b\ .$$

61 $\dot{x}$ in first row

$$m\ddot{x} = \sum f_x = k(x_b - x) + c(\dot{x}_b - \dot{x}) \qquad \textbf{(i)}$$
$$\therefore\ m\ddot{x} + c\dot{x} + kx = c\dot{x}_b + kx_b\ .$$

63 Misplaced decimal point and missing sec: $c = 125.7 N\,\text{sec}/m$

64 In calculating ζ, use 125.7, not 1257

71 1st column $a = .25g = -\omega^2 A$

Denominator "377"

$$A = .25\,(9.81\,m/\sec^2)/377.^2 = 1.726\times 10^{-5}\,m = .017\,mm\ \ .$$

86 The tension T_l can be eliminated by the operation: Eq.(3.84) × cos θ - Eq.(3.83) × sin θ, .. Also on pages 86 and 87 there are several typos where T_1 is used incorrectly instead of T_l .

90

$$\begin{aligned} X_0 &= X(0) = 0, \qquad Y_0 = Y(0) = 0 \\ \dot{X}(0) = \dot{X}_0 &= v_0 \cos\alpha, \qquad \dot{Y}(0) = \dot{Y}_0 = v_0 \sin\alpha_0\ , \end{aligned}$$

91 Second column, Example Problem 3.18
Solution
From Figure XP3.1~~4~~7

93

$$\frac{\dot{\theta}^2}{2} - \frac{\dot{\theta}_0^2}{2} = \frac{g}{r_0}\int_{\theta_0}^{\theta} \cos u\ du = \frac{g}{r_0}\,(\sin\theta - \sin\theta_o)\ , \tag{3.99}$$

97 1st column, last line ...Provided by Equation 3.~~7~~93b ..
2nd column

$$\begin{Bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{Bmatrix} = \begin{Bmatrix} x_2 \\ -\dfrac{g}{l}\sin x_1 - \dfrac{C_a}{ml}x_2^2\, sgn x_2 \end{Bmatrix}. \tag{3.113}$$

107

$$\begin{aligned} \Delta &= [(k_1+k_2) - m_1\omega^2]\ [(k_2+k_3) - m_2\omega^2] - k_2^2 \\ &= m_1 m_2 \omega^4 - [m_1(k_2+k_3) + m_2(k_1+k_2)]\ \omega^2 + (k_1+k_2)(k_2+k_3) - k_2^2 = 0. \end{aligned} \tag{3.142}$$

108

$$(a_{i2}) = \begin{Bmatrix} a_{12} \\ a_{22} \end{Bmatrix} = \begin{Bmatrix} 1 \\ -.36603 \end{Bmatrix}\ .$$

109 Missing + sign in Eq. (3.153), and

$$\begin{bmatrix} (m_1+m_2)l_1^2 & m_2 l_2 l_1 \\ m_2 l_1 l_2 & m_2 l_2^2 \end{bmatrix} \begin{Bmatrix} \ddot{\theta}_1 \\ \ddot{\theta}_2 \end{Bmatrix} + \begin{bmatrix} (w_1+w_2)l_1 & 0 \\ 0 & w_2 l_2 \end{bmatrix} \begin{Bmatrix} \theta_1 \\ \theta_2 \end{Bmatrix} = 0\ . \tag{3.138}$$

110

$$(a_{i1}) = \begin{Bmatrix} 1 \\ 1.2247 \end{Bmatrix} .$$

111

$$\begin{Bmatrix} q_{10} \\ q_{20} \end{Bmatrix} = [A^*]^T[M] \begin{Bmatrix} x_{10} \\ x_{20} \end{Bmatrix} = \begin{bmatrix} .45970 & .62796 \\ .88807 & -.32506 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} \begin{Bmatrix} x_{10} \\ x_{20} \end{Bmatrix}$$

$$= \begin{bmatrix} .45970 & 1.2559 \\ .88807 & -.65012 \end{bmatrix} \begin{Bmatrix} x_{10} \\ x_{20} \end{Bmatrix} = \begin{Bmatrix} .45970 x_{10} + 1.2559 x_{20} \\ .88807 x_{10} - .65012 x_{20} \end{Bmatrix} .$$

$$\begin{Bmatrix} x_1(t) \\ x_2(t) \end{Bmatrix} = \begin{bmatrix} A^*_{11} & A^*_{12} \\ A^*_{21} & A^*_{22} \end{bmatrix} \begin{Bmatrix} q_1(t) \\ q_2(t) \end{Bmatrix} = q_1(t) \begin{Bmatrix} A^*_{11} \\ A^*_{21} \end{Bmatrix} + q_2(t) \begin{Bmatrix} A^*_{12} \\ A^*_{22} \end{Bmatrix} . \tag{3.155}$$

114

$$\ddot{q}_1 + 1.294 \dot{q}_1 + 41.886 q_1 = 0 \ , \quad \ddot{q}_2 + 3.785 \dot{q}_2 + 358.11 q_2 = 0$$

$$\begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{bmatrix} .07377 & .03500 \\ .04287 & -.09034 \end{bmatrix} \begin{Bmatrix} q_1 \\ q_2 \end{Bmatrix} . \tag{i}$$

115

$$\begin{bmatrix} m_1 & 0 \\ 0 & m_2 \end{bmatrix} \begin{Bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{Bmatrix} + \begin{bmatrix} (k_1 + k_2) & -k_2 \\ -k_2 & (k_2 + k_3) \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{Bmatrix} f_{1o} \\ f_{2o} \end{Bmatrix} \sin \omega t \ , \tag{3.158}$$

116

$$\begin{Bmatrix} \ddot{q}_1 + .6340 \, q_1 \\ \ddot{q}_2 + 2.336 \, q_2 \end{Bmatrix} = \begin{bmatrix} .4597 & .6280 \\ .8881 & -.3251 \end{bmatrix} \begin{Bmatrix} f_{10} \\ f_{20} \end{Bmatrix} \sin \omega t$$

$$= \begin{Bmatrix} .4597 f_{10} + .6280 f_{20} \\ .8881 f_{10} - .3251 f_{20} \end{Bmatrix} \sin \omega t \ .$$

$$\begin{Bmatrix} x_1(\omega, t) \\ x_2(\omega, t) \end{Bmatrix}_{ss} = q_{1ss}(\omega, t) \begin{Bmatrix} .4597 \\ .6280 \end{Bmatrix} + q_{2ss}(\omega, t) \begin{Bmatrix} .8881 \\ -.3251 \end{Bmatrix} (m). \tag{3.160}$$

117

$$X_1 = \frac{f_{10}\,[\,-\,m_2\omega^2 + (\,k_2 + k_3\,)\,] + f_{20}k_1}{m_1 m_2\omega^4 - [m_1(k_2+k_3)+m_2(k_1+k_2)]\;\omega^2 + (k_1+k_2)(k_2+k_3) - k_2^2}$$

$$X_2 = \frac{f_{10}\;k_2 + f_{20}[(k_1+k_2)-m_1\omega^2]}{m_1 m_2\omega^4 - [m_1(k_2+k_3)+m_2(k_1+k_2)]\;\omega^2 + (k_1+k_2)(k_2+k_3) - k_2^2}\;. \qquad \textbf{(3.162)}$$

118

$$[M]\{\,-\omega^2(x_{is})\sin\omega t - \omega^2(x_{ic})\cos\omega t\,\} + [C]\{\,\omega(x_{is})\cos\omega t - (x_{ic})\sin\omega t\,\}$$
$$+[K]\{\,(x_{is})\sin\omega t + (x_{ic})\cos\omega t\,\} = \{f_{i0}\}\sin\omega t\;.$$

142 Problem 3.13. $c_A = 6.0\,lb\sec/in$

145 $\zeta \cong 0.0075$

150 3.51 (c) Normalize the eigenvectors ... diagonal matrix ~~with~~ of eigenvalues.

151

$\boxed{x_1(0) = x_2(0) = \dot{x}_1(0) = 0;\quad \dot{x}_2(0) = 1\,\frac{cm}{\sec}}$

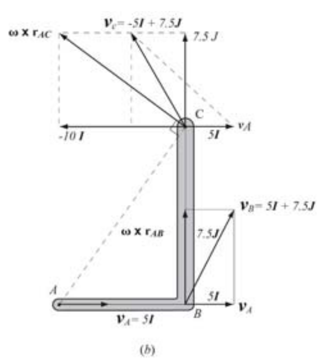
156 1st column, missing r: $\boldsymbol{a_A} = \boldsymbol{\varepsilon_\theta} r\ddot{\theta} - \boldsymbol{\varepsilon_r} r\dot{\theta}^2$

158

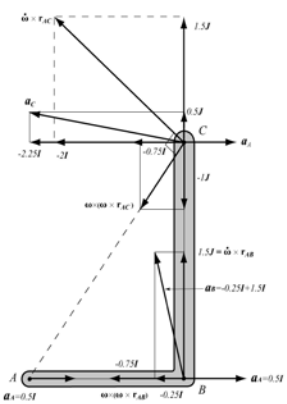
$$\boldsymbol{v_C} = \boldsymbol{v_A} + \boldsymbol{\omega}\times\boldsymbol{r_{AC}} = 5\boldsymbol{I} + .1\boldsymbol{K}\times(75\boldsymbol{I}+100\boldsymbol{J}) = 5\boldsymbol{I} + 7.5\boldsymbol{J} - 10\boldsymbol{I}\;\;mm/\sec$$

159 7.5 $\boldsymbol{J}$ not 7.5 $\boldsymbol{I}$

XP4.1(b) &(c)



(b)


(c)

.

160

$$\boldsymbol{a}_{\boldsymbol{B}}^{/} = \boldsymbol{a_O} + \dot{\boldsymbol{\omega}}\times\boldsymbol{r_{OB'}} + \boldsymbol{\omega}\times(\boldsymbol{\omega}\times\boldsymbol{r_{OB'}}) = \boldsymbol{J}a_o + (\boldsymbol{K}\ddot{\theta}\times .2\boldsymbol{I}) + [\boldsymbol{K}\dot{\theta}\times(\boldsymbol{K}\dot{\theta}\times .2\,I)]$$
$$= \boldsymbol{J}a_o + \boldsymbol{J}\,.2\ddot{\theta} - \boldsymbol{I}.2\dot{\theta}^2 = \boldsymbol{J}(a_O + .2\ddot{\theta}) - \boldsymbol{I}.2\dot{\theta}^2\;\;m/\sec^2 \qquad \textbf{(iii)}$$

$$(-.2\dot{\theta}^2\boldsymbol{I} - .13\boldsymbol{J}) = (.2\dot{\theta}^2\boldsymbol{I} + .13\boldsymbol{J}) + (\boldsymbol{K}\ddot{\theta}\times .4\boldsymbol{I}) + [\boldsymbol{K}\dot{\theta}\times(\boldsymbol{K}\dot{\theta}\times .4\,I)]$$
$$= .2\dot{\theta}^2\boldsymbol{I} + .13\boldsymbol{J} + .4\ddot{\theta}\boldsymbol{J} - .4\dot{\theta}^2\boldsymbol{I}\;\;m/\sec^2$$

$$\boldsymbol{a_o} = \boldsymbol{a_{A'}} + \dot{\boldsymbol{\omega}} \times \boldsymbol{r_{A'o}} + \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \boldsymbol{r_{A'o}}) = (.2\dot{\theta}^2 \boldsymbol{I} + .13\boldsymbol{J}) + (\boldsymbol{K}\ddot{\theta} \times .2\boldsymbol{I}) + [\boldsymbol{K}\dot{\theta} \times (\boldsymbol{K}\dot{\theta} \times .2\boldsymbol{I})]$$
$$= .2\dot{\theta}^2 \boldsymbol{I} + .13\boldsymbol{J} + .2\ddot{\theta}\boldsymbol{J} - .2\dot{\theta}^2 \boldsymbol{I} = (.13 + .2 \times -.65)\boldsymbol{J} = 0\boldsymbol{J}\ m/\sec^2$$

$$\boldsymbol{a_P} = \boldsymbol{a_{A'}} + \dot{\boldsymbol{\omega}} \times \boldsymbol{r_{A'P}} + \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \boldsymbol{r_{A'P}})$$
$$= (.2\dot{\theta}^2 \boldsymbol{I} + .13\boldsymbol{J}) + \boldsymbol{K}\ddot{\theta} \times (.2\boldsymbol{I} + .2\boldsymbol{J}) + \boldsymbol{K}\dot{\theta} \times [\boldsymbol{K}\dot{\theta} \times (.2\boldsymbol{I} + .2\boldsymbol{J})]$$
$$= .2\dot{\theta}^2 \boldsymbol{I} + .13\boldsymbol{J} + .2\ddot{\theta}(\boldsymbol{J} - \boldsymbol{I}) - .2\dot{\theta}^2(\boldsymbol{I} + \boldsymbol{J}) = -.2\ddot{\theta}\boldsymbol{I} + (.13 + .2\ddot{\theta} - .2\dot{\theta}^2)\boldsymbol{J}$$
$$= (-.2 \times -.65)\boldsymbol{I} + [.13 + (.2 \times -.65) - .2 \times 1.5^2]\boldsymbol{J} = 0.13\boldsymbol{I} - 0.45\boldsymbol{J}\ m/\sec^2\ .$$

162

$$\dot{X} = r\dot{\theta} + r\dot{\theta}(-1) = 0\ ,\quad \dot{Y} = -r\dot{\theta}(0) = 0$$
$$\ddot{X} = r\ddot{\theta} + r\ddot{\theta}(-1) - r\dot{\theta}^2(0) = 0\ ,\quad \ddot{Y} = -r\ddot{\theta}(0) - r\dot{\theta}^2(-1) = r\dot{\theta}^2\ . \tag{4.11}$$

164

$$\boldsymbol{a_C} = (\boldsymbol{I}a_{CX} + \boldsymbol{J}a_{CY}) = \boldsymbol{I}\ddot{X}_o + (-\boldsymbol{K}\ddot{\theta} \times -\boldsymbol{J}r) - \boldsymbol{K}\dot{\theta} \times (-\boldsymbol{K}\dot{\theta} \times -\boldsymbol{J}r)$$

$$\boldsymbol{a_D} = \boldsymbol{I}r\ddot{\theta} + (-\boldsymbol{K}\ddot{\theta} \times -\boldsymbol{I}r) - \boldsymbol{K}\dot{\theta} \times (-\boldsymbol{K}\dot{\theta} \times -\boldsymbol{I}r) = \boldsymbol{I}(r\ddot{\theta} + r\dot{\theta}^2) + \boldsymbol{J}r\ddot{\theta}\ .$$

166

$$\boldsymbol{v_C} = \boldsymbol{v_A} + \boldsymbol{\omega} \times \boldsymbol{r_{AC}}\ or,$$
$$-\boldsymbol{I}(1.25\,m/\sec) = 0 + \boldsymbol{K}\dot{\theta}\,(rad/\sec) \times -0.5\,m\boldsymbol{J} = \boldsymbol{I}0.5\,\dot{\theta}\,(m/\sec) \tag{i}$$
$$\therefore\ \dot{\theta} = -1.25/.5 = -2.5\,rad/\sec\ ,\ \boldsymbol{\omega} = -\boldsymbol{K}2.5\,rad/\sec$$

167

$$\boldsymbol{I}:\ 1 = (a_{oX} + \ddot{\theta})\ \Rightarrow\ a_{oX} = (1 - 2) = -1\,m/\sec^2$$
$$\boldsymbol{J}:\ a_{CY} = \dot{\theta}^2 = (-2.5)^2 m/\sec^2 = 6.25\,m/\sec^2\ . \tag{iii}$$

Note that $a_{AY} = r_{oA}\dot{\theta}^2 = 0.5 \times (-2.5)^2 = 3.125\ m/\sec^2$.

169

The wheel that rolled without slipping in the preceding section provides an appropriate "thought model" for the present topic of planar mechanisms. The wheel example had the following two characteristics that ~~carry~~ apply here:

$$\begin{bmatrix} 1 & \sin\varphi \\ 0 & \cos\varphi \end{bmatrix} \begin{Bmatrix} \dot{X}_P \\ l_2\dot{\varphi} \end{Bmatrix} = l_1\omega \begin{Bmatrix} -\sin\theta \\ \cos\theta \end{Bmatrix}\ . \tag{4.18b}$$

170

$$l_1 \cos\theta + l_2 \cos\varphi = X_P \ , \quad l_1 \sin\theta - l_2 \sin\varphi = 0 \ . \qquad \textbf{(4.20a)}$$

175 Equations (4.21) define the position vectors of this equation. Using the right-hand rule, the angular velocity vectors are defined as $\boldsymbol{\omega_1} = \boldsymbol{K}\dot{\alpha}$, $\boldsymbol{\omega_2} = \boldsymbol{K}\dot{\beta}$, and $\boldsymbol{\omega_3} = -\boldsymbol{K}\dot{\gamma}$.

$$\boldsymbol{a_D} + \dot{\boldsymbol{\omega}}_3 \times \boldsymbol{r_{DC}} + \boldsymbol{\omega_3} \times (\boldsymbol{\omega_3} \times \boldsymbol{r_{BC}}) = \boldsymbol{a_A} + \dot{\boldsymbol{\omega}}_1 \times \boldsymbol{r_{AB}} + \boldsymbol{\omega_1} \times (\boldsymbol{\omega_1} \times \boldsymbol{r_{AB}}) + \dot{\boldsymbol{\omega}}_2 \times \boldsymbol{r_{BC}} + \boldsymbol{\omega_2} \times (\boldsymbol{\omega_2} \times \boldsymbol{r_{BC}}) \ .$$

Noting that $\boldsymbol{a_D}$ and $\boldsymbol{a_A}$ are zero, and substituting $\dot{\boldsymbol{\omega}}_1 = \boldsymbol{K}\ddot{\alpha}$, $\dot{\boldsymbol{\omega}}_2 = \boldsymbol{K}\ddot{\beta}$, and $\dot{\boldsymbol{\omega}}_3 = -\boldsymbol{K}\ddot{\gamma}$

$$\begin{aligned} &-\boldsymbol{K}\ddot{\gamma} \times l_3(-\boldsymbol{I}\cos\gamma + \boldsymbol{J}\sin\gamma) - \boldsymbol{K}\dot{\gamma} \times [-\boldsymbol{K}\dot{\gamma} \times l_3(-\boldsymbol{I}\cos\gamma + \boldsymbol{J}\sin\gamma)] = \\ &\boldsymbol{K}\ddot{\alpha} \times l_1(\boldsymbol{I}\cos\alpha + \boldsymbol{J}\sin\alpha) + \boldsymbol{K}\dot{\alpha} \times [\boldsymbol{K}\dot{\alpha} \times l_1(\boldsymbol{I}\cos\alpha + \boldsymbol{J}\sin\alpha)] \\ &+ \boldsymbol{K}\ddot{\beta} \times l_2(\boldsymbol{I}\cos\beta + \boldsymbol{J}\sin\beta) + \boldsymbol{K}\dot{\beta} \times [\boldsymbol{K}\dot{\beta} \times l_2(\boldsymbol{I}\cos\beta + \boldsymbol{J}\sin\beta)] \ . \end{aligned}$$

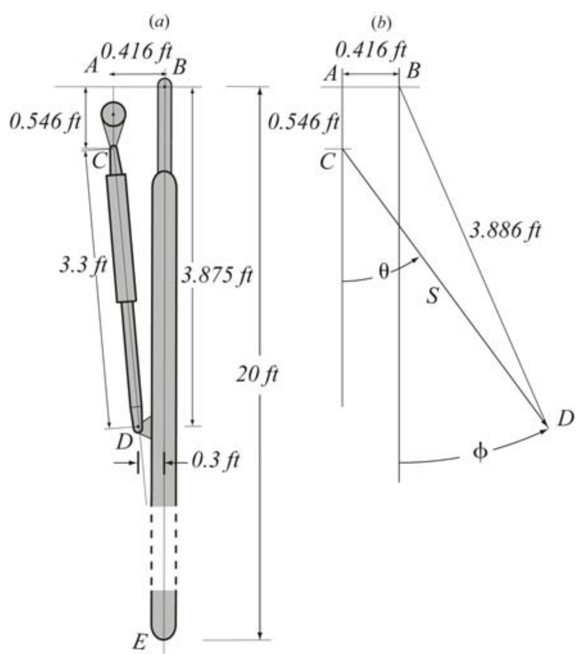
176

$$\begin{aligned} -l_1\cos\alpha + l_2\sin\beta + l_3\cos\gamma = a \ &\Rightarrow \ l_2\sin\beta + l_3\cos\gamma = a + l_1\cos\alpha = h_1(\alpha) \\ l_1\sin\alpha + l_2\cos\beta - l_3\sin\gamma = b \ &\Rightarrow \ l_2\cos\beta - l_3\sin\gamma = b - l_1\sin\alpha = h_2(\alpha), \end{aligned} \qquad \textbf{(i)}$$

177

$$\begin{bmatrix} \cos\beta & -\sin\gamma \\ \sin\beta & \cos\gamma \end{bmatrix} \begin{Bmatrix} l_2\ddot{\beta} \\ l_3\ddot{\gamma} \end{Bmatrix} = \begin{Bmatrix} g_1 \\ g_2 \end{Bmatrix} .$$

182 XP4.6 (a) & (b)



190 Consistent with the problem 4.30 figure, the problem statement should be referring to bar *BC* not *BA* .

196 $\boldsymbol{\rho} = \boldsymbol{i}x + \boldsymbol{j}y + \boldsymbol{k}z$

202 Missing ×

$$\boldsymbol{\rho} \times \ddot{\boldsymbol{r}} = (\boldsymbol{\rho} \times \ddot{\boldsymbol{R}}_o) + \boldsymbol{\rho} \times (\dot{\boldsymbol{\omega}} \times \boldsymbol{\rho}) + \boldsymbol{\rho} \times [\boldsymbol{\omega} \times (\boldsymbol{\omega} \times \boldsymbol{\rho})] \ .$$

203 Missing =

$$m\boldsymbol{b}_{og} = m(\boldsymbol{i}b_{ogx} + \boldsymbol{j}b_{ogy} + \boldsymbol{k}b_{ogz}) = \int_V \boldsymbol{\rho}\gamma\, dx\, dy\, dz = \int_m \boldsymbol{\rho}\, dm \ , \qquad \textbf{(5.2)}$$

$$\boldsymbol{\omega} \times \boldsymbol{\rho} = \boldsymbol{k}\dot{\theta} \times (\boldsymbol{i}x + \boldsymbol{j}y + \boldsymbol{k}z) \ = \ \dot{\theta}(\boldsymbol{j}\ x \ - \ \boldsymbol{i}\ y) \ , \qquad \textbf{(5.30)}$$

204 Think about driving a nail through point *o* in figure ~~5.63~~ 5.8

207 $Work_{n.c.} = (T + V) - (T_0 + V_0) \ldots$

208

$$I_O\ddot{\theta} = T_{c2}r - T_{c1}r = r(w_2 - m_2 r\ddot{\theta}) - r(w_1 + m_1 r\ddot{\theta}) \qquad \textbf{(5.50)}$$

$$y_1 + y_2 + c = cord\ \ length \ \Rightarrow \ \ddot{y}_1 = -\ddot{y}_2 \ .$$

209

$$T = I_O\frac{\dot{\theta}^2}{2} + m_1\frac{(-r\dot{\theta})^2}{2} + m_2\frac{(r\dot{\theta})^2}{2} = (I_O + m_1 r^2 + m_2 r^2)\frac{\dot{\theta}^2}{2}$$

210

$$T + V = T_0 + V_0 \quad \Rightarrow \quad \frac{I_o\dot{\theta}^2}{2} + \frac{m\dot{x}^2}{2} - mg(\bar{x} + \delta x) = T_0 + V_0 \ .$$

211 Figure ~~5.16 a~~ 5.16a illustrates a compound pendulum consisting of a uniform ...

212 (*l* not 1)

$$I_o\ddot{\theta} = \Sigma M_o = -w\frac{l}{2}\sin\theta \ , \ I_o = \frac{ml^2}{3} \qquad \textbf{(5.59)}$$

The degree sign is missing in $(\theta \le \text{about } 15^{\circ} = .262 \text{ radians})$

214 (*l* not 1)

$$V = -w\frac{l}{2}\cos\theta \ . \qquad \textbf{(5.70)}$$

215 Moving to *Task b*, the immediate choice ... (Not italicised)

217 Adding this resistance moment to the moments on the right of Equation ~~(5.33)~~ (5.59) gives (*l* not 1)

$$\frac{ml^2}{3}\ddot{\theta} = -w\frac{l}{2}\sin\theta - C_d\dot{\theta} \ , \qquad \textbf{(5.71)}$$

218 *l* not 1

$$\begin{aligned} \Sigma M_o = I_o\ddot{\theta} &= -w\frac{l}{2}\sin\theta - k\delta_s\cos\beta\times l\cos\theta - k\delta_s\sin\beta\times l\sin\theta \\ &= -w\frac{l}{2}\sin\theta - k\delta_s l\cos(\theta-\beta) \end{aligned} \qquad \textbf{(5.76)}$$

219 For the small displacement of the spring, starting with $T+V=T_0+V_0$, the EOM is.. (T_0+V_0)

222 *l* not 1

$$\begin{aligned} \Sigma M_o = I_o\delta\ddot{\theta} &= -w\frac{l}{2}\sin(\bar{\theta}+\delta\theta) + \frac{2l}{3}k_1(\delta_1 - \frac{2l}{3}\theta) + \frac{2l}{3}k_2(\delta_2 - \frac{2l}{3}\theta) \\ &\cong -w\frac{l}{2}(\sin\bar{\theta} + \cos\bar{\theta}\,\delta\theta) + \frac{2l}{3}k_1\delta_1 + \frac{2l}{3}k_2\delta_2 - (\frac{2l}{3})^2(k_1+k_2)\delta\theta \\ &= (-w\frac{l}{2}\sin\bar{\theta} + \frac{2l}{3}k_1\delta_1 + \frac{2l}{3}k_2\delta_2) - w\frac{l}{2}\cos\bar{\theta}\,\delta\theta - (\frac{2l}{3})^2(k_1+k_2)\delta\theta \ , \end{aligned}$$

$$\frac{ml^2}{3}\delta\ddot{\theta} + [(\frac{2l}{3})^2(k_1+k_2) + w\frac{l}{2}\cos\bar{\theta}]\delta\theta = 0 \ = -w\frac{l}{2}\sin\bar{\theta} + \frac{2l}{3}k_1\delta_1 + \frac{2l}{3}k_2\delta_2 \ . \qquad \textbf{(5.85)}$$

223 (*l* not 1)

$$\frac{ml^2}{3}\delta\ddot{\theta} + [(\frac{2l}{3})^2(k_1+k_2) + w\frac{l}{2}\cos\bar{\theta}]\delta\theta = 0 \ = -w\frac{l}{2}\sin\bar{\theta} + \frac{2l}{3}k_1\delta_1 - \frac{2l}{3}k_2\delta_2 \ . \qquad \textbf{(5.88)}$$

$$\begin{aligned} \Sigma M_0 = I_o\delta\ddot{\theta} &= -w\frac{l}{2}\sin(\bar{\theta}+\delta\theta) + k_x(\delta_x - l\delta\theta\cos\bar{\theta})\times l\cos(\bar{\theta}+\delta\theta) \\ &\quad + k_y(\delta_y - l\delta\theta\sin\bar{\theta})\times l\sin(\bar{\theta}+\delta\theta) \end{aligned}$$

248

$$\int_{\beta_0}^{\pi/2} 2\bar{f}\,l\cos\beta\,d\beta = 2\bar{f}l(1-\sin\beta_0) = \frac{m\ l^2}{3}\ \dot{\beta}^2(\beta=\pi/2) + 2wl(1-\sin\beta_0) + 2kl^2(1-\sin\beta_0)^2 \ ,$$

251

$$T = 2\times\frac{I_O\dot{\theta}^2}{2} + 2\times\left[\frac{I_g\dot{\theta}^2}{2} + \frac{m}{2}(\dot{X}_g^2 + \dot{Y}_g^2)\right] + \frac{m}{2}(l\dot{\theta})^2 + \left(\frac{I_B\dot{\beta}^2}{2} + \frac{M\dot{X}_r^2}{2}\right) . \qquad \textbf{(5.191)}$$

258

$$\begin{Bmatrix} \bar{f}_X \\ \bar{M}_Y \end{Bmatrix} = -[k_{XZ}]\begin{Bmatrix} R_X \\ \beta_Y \end{Bmatrix} = -\begin{bmatrix} 12EI_a/l^3 & -6EI_a/l^2 \\ -6EI_a/l^2 & 4EI_a/l \end{bmatrix}\begin{Bmatrix} R_X \\ \beta_Y \end{Bmatrix} . \qquad \textbf{(5.214)}$$

260 Denominator $(6m)^3$

$$k_c = \frac{12EI_{a1}}{l^3} = \frac{12(1.75\times 10^6)\,Nm^2}{(6m)^3} = 97200\,\frac{N}{m}$$

296 Problem 5.26 Determine the angular velocity...

300 Problem 5.45 The bar assembly shown in Figure P5.45 is being pulled upward by a vertical force ***F*** at *B*. The spring connecting *O* and *A* is undeflected when the roller at *B* is resting on *O*.

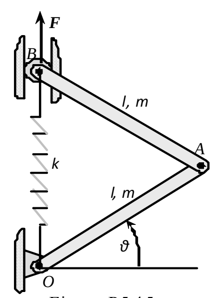


Figure P5.45

307 Problem 5.71

(c) For the data provided~~ below~~, obtain the eigenvalues, normalized eigenvectors, and natural frequencies of the system.

Problem 5.74

….. A small ~~mass~~ roller at *B* (negligible mass an inertia) supports the right end of bar *AB*.

310 Problem 5.85

…….Links *OB*'s mass center is located at distance $\bar{r}$ from *O*.

Problem 5.86

…..The mass center of wheel *B* is at O_2 and has a radius of gyration of k_{2g} about point O_2. *P*in *C* is fixed to disk *A* and is located a distance *r* from the pivot O_1. Disk *A's* mass center is located at $\bar{r}$ from point O_1. Disk *A* has mass m_1 and a radius of gyration of k_{1g} about point O_1.

311 Problem 5.90

(a) Select coordinates and state the kinematic constraint relationships.

312 Problem 5.91

……. and link *BC* is a uniform bar of mass *M*.

Problem 5.92

(a) Select coordinates and state the kinematic constraint relationships.

NOTE: Original problem had torque ***T*** acting on the disc at *O*, and appears in answer.

313 Matrix algebra requires that the number of ~~rows~~ columns in the first matrix equal the number of ~~columns~~ rows in the second matrix.

$$(\ddot{q})_i + [\Lambda](q_i) = (Q_i) = [A^*]^T(f_i) = \begin{bmatrix} A^*_{11} & A^*_{21} \\ A^*_{12} & A^*_{22} \end{bmatrix} \begin{Bmatrix} f_1 \\ f_2 \end{Bmatrix}$$

$$= \begin{Bmatrix} A^*_{11} f_1 + A^*_{21} f_2 \\ A^*_{12} f_1 + A^*_{22} f_2 \end{Bmatrix}. \tag{3.153}$$

330 In the last figure for problem 2.7. $a_n = 0.0\cancel{0}996$

333 1st column

$$\begin{Bmatrix} a_t \\ a_n \end{Bmatrix} = \begin{Bmatrix} 683 \\ 1267 \end{Bmatrix} m/\sec^2$$

2nd column

$$\begin{Bmatrix} a_r \\ a_\theta \end{Bmatrix} = \begin{Bmatrix} -1695 \\ -242 \end{Bmatrix} \times 10^3 \ mm/\sec^2$$

335 Bottom of the page, 2nd column $\begin{matrix} \theta = 323° \\ \beta = 333° \end{matrix}$

339 Answer, problem 2.20

$$\begin{Bmatrix} v_r \\ v_\theta \end{Bmatrix} = \begin{Bmatrix} -5.78 \\ -39.6 \end{Bmatrix}, \quad \begin{Bmatrix} a_r \\ a_\theta \end{Bmatrix} = \begin{Bmatrix} 29.68 \\ -4.25 \end{Bmatrix}$$

342 $\ddot{X} + 5.02\dot{X} + 1000X = 0.03333\,t^2 - 0.1\,t$

344 3.27(b), $a = 0.913$ mm

345 answer, missing 2 in denominator

$$\zeta = \frac{c_b}{2\sqrt{(k_B + 9k_C)(m_B + 9m_C)}}$$

346

$$(m_b + 9m_c)\ddot{X} + c_B\dot{X} + (k_B + 9k_C) = w_B - 3w_C$$

350 problem 4.21: (a) $v_B = -344.4\,in/s$ (b) $a_B = -212087\,in/s^2$

353 4.35

$$\dot{S} = \frac{-l_1\dot{\theta}\sin(\theta + \varphi)}{\cos\varphi}, \quad \dot{\varphi} = \frac{-l_1\dot{\theta}\cos\theta}{l_2\cos\varphi}$$

4.37c $\boldsymbol{v_C} = -\boldsymbol{I}(r\dot{\theta}\sin\theta + L\dot{\varphi}\sin\varphi) - \boldsymbol{J}(r\dot{\theta}\cos\theta + L\dot{\varphi}\cos\varphi)$

357 5.26 $\ddot{\theta} = \frac{3}{2L}(a_O\cos\theta + g\sin\theta)$

359 5.45 $\left(\frac{2}{3} + 2\cos^2\theta\right)ml\ddot{\theta} - ml\dot{\theta}^2\sin 2\theta + 2mg\cos\theta + 2kl\sin 2\theta = 2FL\cos\theta$