

0v%´ ([Ò /ø³ ó-) +±N g š 7 *^ ÓL<3ì T N
 , 'NĀN ý ' ³ V*U Ō . E3æ" ? à N g Dô^ ELg
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 c +± ž ú %´ ([xŌU' /ø³ L< Ç e ! A Ō È N , +±
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 Ō c "£ A U < Dû>ý¹ TDû>ýg EĎô ÂêÆ4 • æ
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 . N g / Ç¹ - Ç +± ú 3âî BU%´ ([Öý ' ³ -
 .ú ' » >Kqç 4-4 ¹ Ō . L• Ō c æ" +± Dô^ ELg
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 L<3ì T d Ž +± Ō c • Á * U » N =y 23ì D° T +± P T
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 E Ä g TDû>ýg Ō L<3ì T QŌý Ō c æ" " N , +± :
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 > î " Ō . E3æ" ¹ £ f E æ" 4 5 Ē (Ý³ N g Dô
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 Ō c # L< Ç e ! A Ō È BB +± Ō c A ¹ Ō c E \$ "
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& » u E E Ä g Dô^ ELg Ō Ō c " £ h > @ Ō c
 Füg ! A " n > ý % A " n > ý ¹ 6 D j > ý EL (' +± N , - 8

$$\alpha = q - \frac{V_L \rho_o \omega^2}{\rho_o \omega} + \frac{z \rho_o \omega}{\rho_o \omega} +$$

$$\frac{\rho_o L + Mg}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} + \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} +$$

$$\frac{\rho_o T_x}{\rho_o \omega} \frac{z \rho_o \omega}{\rho_o \omega} + \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} +$$

$$\beta = -r \frac{\rho_o \omega}{\rho_o \omega} + p \frac{z \rho_o \omega}{\rho_o \omega} +$$

$$\frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} + Mg \frac{\rho_o \omega}{\rho_o \omega} \frac{z \rho_o \omega}{\rho_o \omega} +$$

$$\frac{\rho_o T_x}{\rho_o \omega} \frac{z \rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} + \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} -$$

$$\frac{\rho_o T_z}{\rho_o \omega} \frac{z \rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} + \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} -$$

$$\mu = \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} + \frac{z \rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} +$$

$$\frac{\rho_o L}{\rho_o \omega} \frac{V_L \rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} + \frac{V_L \rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} -$$

$$\frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} + \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} +$$

$$\frac{\rho_o \omega}{\rho_o \omega} + T_y \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} +$$

$$\frac{\rho_o \omega}{\rho_o \omega} \frac{z \rho_o \omega}{\rho_o \omega} - T_z \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} \frac{V_L \rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} +$$

$$\frac{\rho_o \omega}{\rho_o \omega} \frac{z \rho_o \omega}{\rho_o \omega} - T_z \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} \frac{V_L \rho_o \omega}{\rho_o \omega} -$$

$$\frac{\rho_o T_x}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} \frac{V_L \rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} + \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} -$$

$$\frac{\rho_o T_z}{\rho_o \omega} \frac{z \rho_o \omega}{\rho_o \omega} \frac{V_L \rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} + \frac{\rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} \frac{V_L \rho_o \omega}{\rho_o \omega} \frac{\rho_o \omega}{\rho_o \omega} -$$

$$p = \frac{I_{zz} l + I_{xz} n}{I_{xx} I_{zz} - I_{xz}^2} + \frac{I_{xz} \rho_{xx} - I_{yy} + I_{zz} o}{I_{xx} I_{zz} - I_{xz}^2} pq +$$

$$\frac{I_{zz} \rho_{yy} - I_{zz} o - I_{xz}^2}{I_{xx} I_{zz} - I_{xz}^2} qr$$

$$w_i = [w_{iB} \ w_{i0} \ - \ w_{in}]$$

$$x_j = [x_{jB} \ x_{j0} \ - \ x_{nj}]$$

F %00< AE=

$$HB = T \quad \%00$$

< Z "H g i Âè¶+±K½X oDÀ'

$$H = \begin{bmatrix} g_{\omega_0 x_B} + b_{00} & g_{\omega_0 x_B} + b_{00} & - g_{\omega_0 x_B} + b_{00} \\ g_{\omega_0 x_0} + b_{00} & g_{\omega_0 x_0} + b_{00} & - g_{\omega_0 x_0} + b_{00} \\ \dot{E} & \dot{E} & \dot{E} \\ g_{\omega_0 x_Q} + b_{00} & g_{\omega_0 x_Q} + b_{00} & - g_{\omega_0 x_Q} + b_{00} \end{bmatrix}_{Q \times l}$$

$$\beta = H^+ T \quad \%00$$

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#p>ÿ- Kc) • 1 4VüM¼ %00g 6ÂX+±DÀ' FÜ"59
6Dj È2(• 1 È- 2(• %00g DÀ' FÜ%U 6ÂX @Ü
3ð# 3 7E DÀ' FÜ%00g N, DÀ' "59 3 6Dj È2(
• 1 È- 2(• +±MÜKA O'i %00g N, @5ð# +±Fðd
i " ' @5ðä Ä N, 4 ± i • %

$$< Z, \% \quad F\ddot{u}\ddot{C}v^{-} 8$$

$$x_B = [p \ q \ r]$$

$$x\ddot{A} = V^{\alpha} \beta^p \beta^q \beta^r \ddot{O}$$

$$u = \delta_e \delta_a \delta_r \delta_{ij} \delta_{hj} - \delta_x \delta_y \delta_z \ddot{O} \quad \%00$$

$$f_f \% \ddot{A} = [f_p \% \ddot{A} \ f_q \% \ddot{A} \ f_r \% \ddot{A}] \quad \%00$$

$$f_p \% \ddot{A} = \frac{I_{zz} I_{xx}^2 + I_{xx} I_{zz}^2 - I_{xy}^2 + I_{zz} Q_p q}{I_{xx} I_{zz} - I_{xz}^2} +$$

$$\frac{I_{zz} I_{yy} - I_{zz}^2 - I_{xz}^2 Q_p r}{I_{xx} I_{zz} - I_{xz}^2}$$

$$f_q \% \ddot{A} = \frac{I_{zz} I_{xx}^2 + I_{xx} I_{zz}^2 - I_{xy}^2 + I_{zz} Q_p q}{I_{xx} I_{zz} - I_{xz}^2} +$$

$$\frac{I_{xx} I_{yy} - I_{zz}^2 - I_{xz}^2 Q_p r}{I_{xx} I_{zz} - I_{xz}^2}$$

$$f_r \% \ddot{A} = \frac{I_{xx} I_{yy} - I_{zz}^2 - I_{xz}^2 Q_p r}{I_{xx} I_{zz} - I_{xz}^2} +$$

< Z "I³/4 Ixx nÄ+ %00 %00 - Iyy o + Izz Qpq
3â È- %g %Ä o g ú3â u6*- Kb" A ü W>ÿELÓ
C, %Ä+±i g

$$g_{pi} \% \ddot{A} = \frac{I_z C_{li} + I_{xz} C_{mi}}{I_{xx} I_{zz} - I_{xz}^2} q$$

$$g_{qi} \% \ddot{A} = \frac{C_{mi}}{I_{yy}} q$$

$$g_{ri} \% \ddot{A} = \frac{I_x C_{ni} + I_{xz} C_{li}}{I_{xx} I_{zz} - I_{xz}^2} q \quad \%00$$

ææU Ôc , @ @î# "L H+±6Dj >ÿEL(g

$$\begin{bmatrix} \dot{p}_d \\ \dot{q}_d \\ \dot{r}_d \end{bmatrix} = \begin{bmatrix} \omega_p & ! & ! \\ ! & \omega_q & ! \\ ! & ! & \omega_r \end{bmatrix} \begin{bmatrix} p_c - p \\ q_c - q \\ r_c - r \end{bmatrix} \quad \%0!$$

< Z âp_c "q_c "r_c g L H C DÀ' \$ " ^ C C @î
0ÄÄ] t_p "ω_q "ω_r g S ê i • %

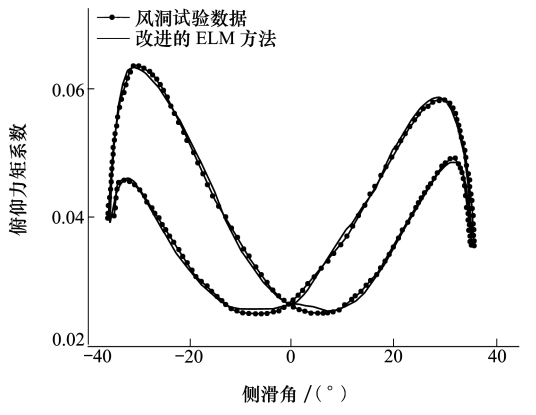
FöU' » _ ÖJ+3Fzæ" +±Ö . E3 C @ @î
J âL H+±6Dj È- 2(• u E D ð e >ñ! A Ö7bL • |
D T Ô * L " - É e >ñ7bL • D è] ELÓ C z 4 } K } c " - † + ±
L H È- 2(• ° * ^ Ô È- FÜ Ô * L " E d E - z Ô È
- Füp Ô g J - # K! 1 » %ä . " # J - Ô È- Füp
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[p_d q_d r_d] + ± @ D Ä Z B ' / 3 (Ü T " UL' Ç e ! A

* ^ 7E = • D è < - ä e >ñ Ö . E3 æ" U C
[p_d q_d r_d] + ± @ D Ä # \ | ... S ê %50; ~
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[p_d q_d r_d] + ± @ D Ä Z B ' / 3 (Ü T " UL' Ç e ! A

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[p_d q_d r_d] + ± @ D Ä Z B ' / 3 (Ü T " UL' Ç e ! A

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[p_d q_d r_d] + ± @ D Ä # \ | ... S ê %50; ~
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[p_d q_d r_d] + ± @ D Ä Z B ' / 3 (Ü T " UL' Ç e ! A



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L' Ç e ! A Ô È ' N4 É

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/ø ó - > + ± ù D j 5 S 5 \ 8 Z L' Ç e ! A Ô È N , " g ; 4
Dô ^ ELg Ô ý È ³ L + ± A Ô N , %

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T æ" = • g g

$$x_B = f_f \% \ddot{A} + g_f \% \ddot{A} u \quad \%00$$

$$y_B = x_B$$

Õ È 1 e>ñ!A Õ È | D°T # "A C Ô c , ú
ÄD°a +±Ô c 1ë Ó %%%! o < ÆEg

$$\begin{bmatrix} \dot{p}_d \\ \dot{q}_d \\ \dot{r}_d \end{bmatrix} = \begin{bmatrix} \omega_p & ! & ! \\ ! & \omega_q & ! \\ ! & ! & \omega_r \end{bmatrix} \begin{bmatrix} p_c - p \\ q_c - q \\ r_c - r \end{bmatrix} + \begin{bmatrix} \omega_{p_i} \ddot{U} - p \cdot 0 \\ \omega_{q_i} \ddot{U} - q \cdot 0 \\ \omega_{r_i} \ddot{U} - r \cdot 0 \end{bmatrix}$$

%0ß0

< Z "w_{pi} "w_{qi} "w_{ri} 3 X g 6 Di>ÿEL(' A +±/ 3
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3 & AŽ1 Ô c 2(4 & "µ x z +±6 Di>ÿEL(+±L H
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Ô c , ? 0ÄDÀ' α_c "β_c "µ_c "D°• C DÀ' p_c "q_c "r_c %
D°• C Fú ÆEg

$$\dot{x}_0 = f_m \ddot{A} + g_m \ddot{A} \alpha_\beta + g_m \ddot{A} \alpha_i$$
$$y_0 = x_0$$

%000

< Z

$$x_\beta = p "q "r \ddot{O}$$

$$x_0 = \alpha " \beta " \mu \ddot{O}$$

$$x_{\ddot{A}} = V " \gamma " \alpha " \beta " \mu \ddot{O} \quad \%0 \ 0$$

%00< 2 X5S5!A Õ È & C 1 C C 2(÷ ú
3â È %f_m %Ä_m o g X5S5!A Õ È

$$f_m \ddot{A} = [f_\alpha \ddot{A} \ 0 \ f_\beta \ddot{A} \ 0 \ f_\mu \ddot{A} \ 0] \quad \%0 \times 0$$

< Z

$$f_\alpha \ddot{A} = x - \ddot{A} + Mg \ddot{U} \cdot \%0 \ 0 \ddot{U} \cdot \%0 \ 0 -$$

$$\ddot{e} \Gamma_x = \ddot{z} \%0 \ 0 + T_z \ddot{U} \cdot \%0 \ 0 \omega_{mV} \ddot{U} \cdot \%0 \ 0$$

$$f_\beta \ddot{A} = x Mg \ddot{U} \cdot \%0 \ 0 = \ddot{z} \%0 \ 0 - T_x \ddot{U} \cdot \%0 \ 0 = \ddot{z} \%0 \ 0 +$$

$$\ddot{e} \ddot{A} \ddot{U} \cdot \%0 \ 0 + T_y \ddot{U} \cdot \%0 \ 0 -$$

$$\ddot{e} \Gamma_z = \ddot{z} \%0 \ 0 = \ddot{z} \%0 \ 0 \omega_{mV}$$

$$f_\mu \ddot{A} = x \ddot{U} \cdot \%0 \ 0 \omega_{mV} \ddot{U} \cdot \%0 \ 0 + \omega_{mV} \%0 \ 0 +$$

$$\ddot{e} \%0 \ 0 + T_y \omega_{mV} \%0 \ 0 \ddot{U} \cdot \%0 \ 0 \ddot{U} \cdot \%0 \ 0 -$$

$$\ddot{e} n g \ddot{U} \cdot \%0 \ 0 \ddot{U} \cdot \%0 \ 0 \omega_{mV} \%0 \ 0 +$$

$$\ddot{e} \%0 \ 0 = \ddot{z} \%0 \ 0 - T_z \ddot{U} \cdot \%0 \ 0 \omega_{mV} \%0 \ 0 = \ddot{z} \%0 \ 0 +$$

$$\ddot{e} \%0 \ 0 = \ddot{z} \%0 \ 0 - T_z \ddot{U} \cdot \%0 \ 0 \omega_{mV} \%0 \ 0 -$$

$$\ddot{e} \Gamma_x \ddot{U} \cdot \%0 \ 0 \omega_{mV} \%0 \ 0 \ddot{U} \cdot \%0 \ 0 = \ddot{z} \%0 \ 0 -$$

$$\ddot{e} \Gamma_z = \ddot{z} \%0 \ 0 \omega_{mV} \%0 \ 0 \ddot{U} \cdot \%0 \ 0 = \ddot{z} \%0 \ 0 \omega_{mV} \quad \%0 " \ 0$$

g_m %Ä_m o g x_β ; x₀ +±Dý Õ " 2(" = • . g g

$$g_m \ddot{A} = \begin{bmatrix} - \ddot{U} \alpha \omega_\beta \ \beta - \ddot{z} \alpha \omega_\beta \\ \ddot{z} \alpha \ ! \ - \ddot{U} \alpha \\ \ddot{U} \beta \ ! \ \ddot{z} \alpha \\ \ddot{U} \beta \ \ddot{U} \beta \end{bmatrix} \quad \%0 \ 0$$

g_m %Ä_m o g ú 3â È F 3 " EGe ò â 8 N g 7bL • ú 3â
È - • i E T » ú 3â È • i " g_m %Ä_m = ! " ú 59A
C +± Ô c \ : 1ë > +± %

9 d "D°• C +±L H \$ = • . g g

$$\begin{bmatrix} \dot{\alpha}_d \\ \dot{\beta}_d \\ \dot{\mu}_d \end{bmatrix} = \begin{bmatrix} \omega_\alpha & ! & ! \\ ! & \omega_\beta & ! \\ ! & ! & \omega_\mu \end{bmatrix} \begin{bmatrix} \alpha_c - \alpha \\ \beta_c - \beta \\ \mu_c - \mu \end{bmatrix} \quad \%0 \ 0$$

ææ lo Ä C +±L HDÀ' g

$$\begin{bmatrix} p_c \\ q_c \\ r_c \end{bmatrix} = g_m^{-\beta} \ddot{A} \begin{bmatrix} \dot{\alpha}_d \\ \dot{\beta}_d \\ \dot{\mu}_d \end{bmatrix} - \begin{bmatrix} f_\alpha \%3/0 \\ f_\beta \%3/0 \\ f_\mu \%3/0 \end{bmatrix} \quad \%0 \ 0$$

< Z "α_d "β_d 1 μ_d g L HD°• C Õ. ú Á %Y '
Z "α_c "β_c "μ_c t \ ^* 4 \$ Ô *L " £ Z K =
> ±K %α "ω_β "ω_μ 0%

*^ » L(Ç e!A Õ È ±± %*U ") 7! e>ñ Õ. E3æ
" Ô c 4 É ± 6 RFú +± \$ T " £ h > ® \ , %z
\$; EM = ± % ' " Fô *U_5 * \$; N • = ò 4) f ±
e>ñ Õ. E3æ" Ô c 4 É +± E \$ T % f › 7 E 3
½ " » Õ. E3æ" D°• C +±L H2(4 ÆEg

$$\begin{bmatrix} \dot{\alpha}_d \\ \dot{\beta}_d \\ \dot{\mu}_d \end{bmatrix} = G_c \begin{bmatrix} \omega_\alpha & ! & ! \\ ! & \omega_\beta & ! \\ ! & ! & \omega_\mu \end{bmatrix} \begin{bmatrix} \alpha_c - \alpha \\ \beta_c - \beta \\ \mu_c - \mu \end{bmatrix} \quad \%0 \ 0$$

< Z "G_c %00 g \$; N • = ò 4)

$$G_c \%00 = [G_\alpha \%00 \ G_\beta \%00 \ G_\mu \%00] =$$

$$\begin{bmatrix} s/\omega_{c\alpha} + \beta & s/\omega_{c\beta} + \beta & s/\omega_{c\mu} + \beta \\ s/\omega_{d\alpha} + \beta & s/\omega_{d\beta} + \beta & s/\omega_{d\mu} + \beta \end{bmatrix} \quad \%0! \ 0$$

ææ f E ; +±D°• C DÀ' g

$$\begin{bmatrix} p_c \\ q_c \\ r_c \end{bmatrix} = g_m^{-\beta} \ddot{A} G_c \begin{bmatrix} \omega_\alpha & ! & ! \\ ! & \omega_\beta & ! \\ ! & ! & \omega_\mu \end{bmatrix} \begin{bmatrix} \alpha_c - \alpha \\ \beta_c - \beta \\ \mu_c - \mu \end{bmatrix} - g_m^{-\beta} \ddot{A} \begin{bmatrix} f_\alpha \ddot{A} \ddot{O} \\ f_\beta \ddot{A} \ddot{O} \\ f_\mu \ddot{A} \ddot{O} \end{bmatrix} \quad \%0 \ 0$$

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$$\begin{bmatrix} \dot{\alpha} \\ \dot{\beta} \\ \dot{\mu} \end{bmatrix} = \begin{bmatrix} f_\alpha \ddot{A} \ddot{O} \\ f_\beta \ddot{A} \ddot{O} \\ f_\mu \ddot{A} \ddot{O} \end{bmatrix} + g_m \ddot{A} \begin{bmatrix} p_c \\ q_c \\ r_c \end{bmatrix} = \begin{bmatrix} \dot{\alpha}_d \\ \dot{\beta}_d \\ \dot{\mu}_d \end{bmatrix} \quad \%0 \ 0$$

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$$x_{\beta} = f_f \tilde{A} + g_f \tilde{A} - \beta \tilde{A} - f_f \tilde{A} = 0$$

$$\begin{bmatrix} \omega_p & ! & ! \\ ! & \omega_q & ! \\ ! & ! & \omega_r \end{bmatrix} \begin{bmatrix} p_c - p \\ q_c - q \\ r_c - r \end{bmatrix} + \begin{bmatrix} \omega_{p_i} \ddot{U} - p_o \\ \omega_{q_i} \ddot{U} - q_o \\ \omega_{r_i} \ddot{U} - r_o \end{bmatrix}$$

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$$q = \omega_q \ddot{U} - q_o + \omega_{q_i} \ddot{U} - q_o$$

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$$sq = \omega_q \ddot{U} - q_o + \omega_{q_i} \ddot{U} - q_o$$

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$$\frac{q}{q_c} = \frac{\omega_q s + \omega_{q_i}}{s^0 + \omega_q s + \omega_{q_i}}$$

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$$x_0 = G_c \begin{bmatrix} \omega_{\alpha} & ! & ! \\ ! & \omega_{\beta} & ! \\ ! & ! & \omega_{\mu} \end{bmatrix} \begin{bmatrix} \alpha_c - \alpha \\ \beta_c - \beta \\ \mu_c - \mu \end{bmatrix}$$

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$$\alpha = G_{\alpha} \omega_{\alpha} - \alpha_o$$

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$$\frac{\alpha}{\alpha_c} = \frac{\omega_{D\alpha} \omega_{\alpha} \frac{\beta}{\omega_{C\alpha}} s + \omega_{D\alpha} \omega_{\alpha}}{s^0 + \omega_{D\alpha} \left(\frac{\omega_{\alpha}}{\omega_{C\alpha}} + \beta \right) s + \omega_{D\alpha} \omega_{\alpha}}$$

%o o

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 0v u g - W¹ KqÜ7 % & » A ¹ KqÜ7 " Ç ω_n =

$$\omega_{D\alpha} \left(\frac{\omega_{\alpha}}{\omega_{C\alpha}} + \beta \right) \omega_n^0 = \omega_{D\alpha} \frac{\omega_{\alpha}}{\omega_{C\alpha}} \% 3 \frac{1}{2} \text{ Ä åUE6 Ô}$$

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$$\alpha = \alpha_1 + \alpha_m = \text{const } 0$$

$$\dot{\alpha} = \omega \alpha_m \ddot{U} = \text{const } 0$$

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$$\omega = \frac{|\dot{\alpha}|}{\sqrt{\alpha_m^0 - \omega_0 - \alpha_1^0}}$$

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$$k = \frac{0 f c}{V}$$

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$$k = \frac{|\dot{\alpha}| c}{V \sqrt{\alpha_m^0 - \omega_0 - \alpha_1^0}}$$

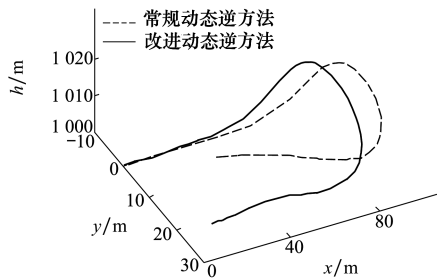
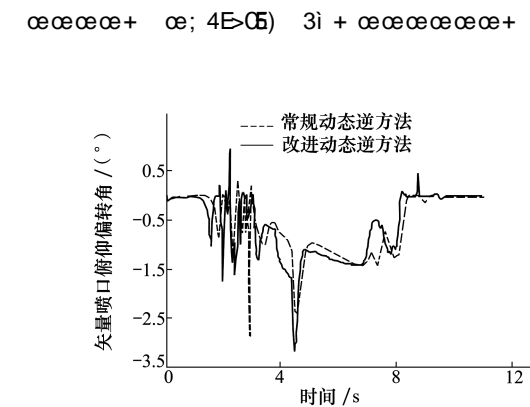
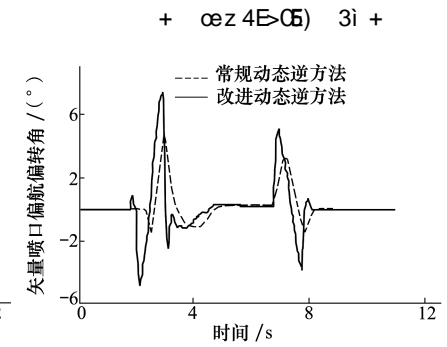
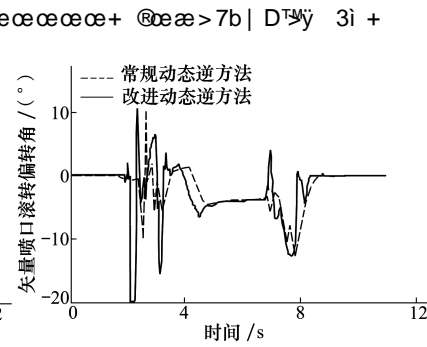
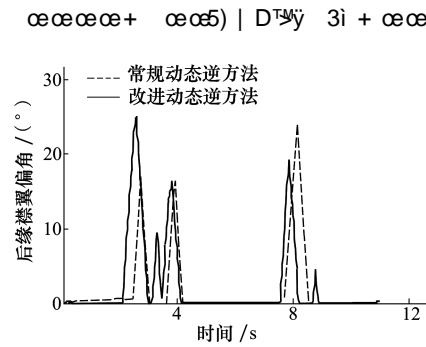
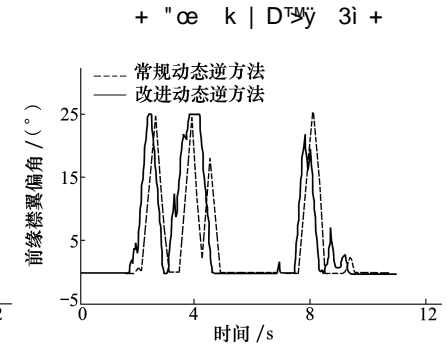
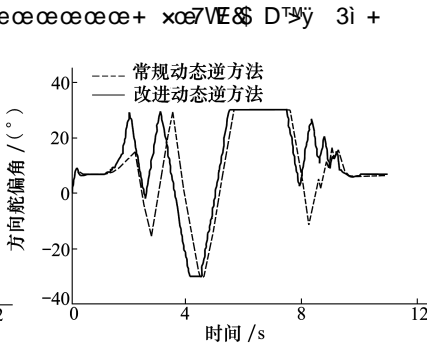
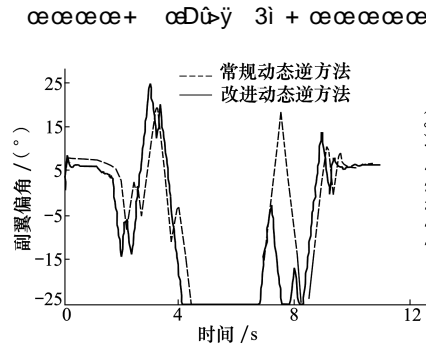
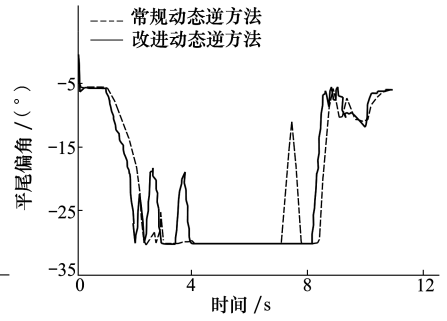
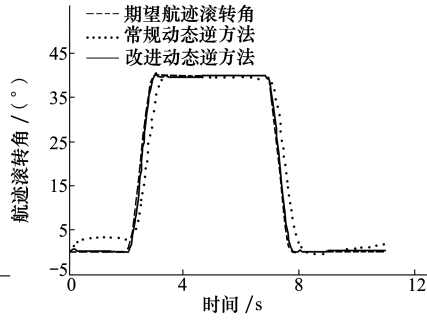
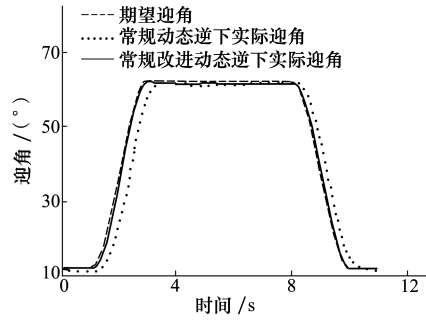
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