

	<b>List of Figures</b>	<b>Page No.</b>
<b>Figure 1.1</b>	Lorenz system	20
<b>Figure 1.2</b>	Phase portrait of the fractional order Lorenz system at the derivative order (a) $q_1 = q_2 = q_3 = 0.99$ ; (b) $q_1 = q_2 = q_3 = 0.98$	22
<b>Figure 2.1</b>	Phase portraits of the complex Lorenz system for the order of derivative $q = 0.95$ in (a) $x_1 - x_2 - x_3$ space; (b) $x_1 - x_2 - x_4$ space; (c) $x_1 - x_2 - x_5$ space; (d) $x_2 - x_3 - x_4$ space; (e) $x_2 - x_3 - x_5$ space; (f) $x_3 - x_4 - x_5$ space.	52
<b>Figure 2.2</b>	Phase portraits of the complex Lu system for the order of derivative $q = 0.96$ in (a) $y_1 - y_2 - y_3$ space; (b) $y_1 - y_2 - y_4$ space; (c) $y_1 - y_2 - y_5$ space; (d) $y_2 - y_3 - y_4$ space; (e) $y_2 - y_3 - y_5$ space; (f) $y_3 - y_4 - y_5$ space.	56
<b>Figure 2.3</b>	Phase portraits of the complex T system for the order of derivative $q = 0.94$ in (a) $z_1 - z_2 - z_3$ space; (b) $z_1 - z_2 - z_4$ space; (c) $z_1 - z_2 - z_5$ space; (d) $z_2 - z_3 - z_4$ space; (e) $z_2 - z_3 - z_5$ space; (f) $z_3 - z_4 - z_5$ space.	60
<b>Figure 2.4</b>	Plots of state trajectories of system (2.10) and system (2.17) for standard order $q = 1$ between (a) $x_1(t)$ and $y_1(t)$ ; (b) $x_2(t)$ and $y_2(t)$ ; (c) $x_3(t)$ and $y_3(t)$ ; (d) $x_4(t)$ and $y_4(t)$ ; (e) $x_5(t)$ and $y_5(t)$ .	65
<b>Figure 2.5</b>	Plots of error functions between system (2.10) and system (2.17): for the order of the derivatives (a) $q = 0.70$ ;	67

(b)  $q = 0.85$  ; (c)  $q = 1$  .

- Figure 2.6** Plots of state trajectories of system (2.13) and system (2.22) for standard order  $q = 1$  between: (a)  $y_1(t)$  and  $z_1(t)$ ; (b)  $y_2(t)$  and  $z_2(t)$ ; (c)  $y_3(t)$  and  $z_3(t)$ ; (d)  $y_4(t)$  and  $z_4(t)$ ; (e)  $y_5(t)$  and  $z_5(t)$ . 72
- Figure 2.7** Plots of error functions between system (2.13) and system (2.22) for: (a)  $q = 0.70$  ; (b)  $q = 0.85$  ; (c)  $q = 1$  . 73
- Figure 2.8** Plots of state trajectories of system (2.10) and system (2.22) for standard order  $q = 1$  between: (a)  $x_1(t)$  and  $z_1(t)$ ; (b)  $x_2(t)$  and  $z_2(t)$ ; (c)  $x_3(t)$  and  $z_3(t)$ ; (d)  $x_4(t)$  and  $z_4(t)$ ; (e)  $x_5(t)$  and  $z_5(t)$ . 77
- Figure 2.9** Plots of error functions between system (2.10) and system (2.22) for: (a)  $q = 0.70$  ; (b)  $q = 0.85$ ; (c)  $q = 1$  . 79
- Figure 3.1** Phase portraits of the fractional order complex Lorenz system with uncertain parameters for the order of the derivative  $q = 0.95$  in: (a)  $x_1 - x_2 - x_3$  space; (b)  $x_1 - x_2 - x_4$  space; (c)  $x_1 - x_2 - x_5$  space; (d)  $x_2 - x_3 - x_4$  space; (e)  $x_2 - x_3 - x_5$  space; (f)  $x_3 - x_4 - x_5$  space. 89
- Figure 3.2** Phase portraits of the fractional order complex T-system with uncertain parameters for the order of the derivative  $q = 0.94$  in: (a)  $y_1 - y_2 - y_3$  space; (b)  $y_1 - y_2 - y_4$  space; (c)  $y_1 - y_2 - y_5$  space; (d)  $y_2 - y_3 - y_4$  space; (e)  $y_2 - y_3 - y_5$  space; (f)  $y_3 - y_4 - y_5$  space. 93

<b>Figure 3.3</b>	Plots of state trajectories of drive system (3.11) and response system (3.15) for fractional order $q = 0.95$ between: (a) $x_1(t)$ and $y_1(t)$ ; (b) $x_2(t)$ and $y_2(t)$ ; (c) $x_3(t)$ and $y_3(t)$ ; (d) $x_4(t)$ and $y_4(t)$ ; (e) $x_5(t)$ and $y_5(t)$ .	97
<b>Figure 3.4</b>	Plots of error functions between of drive system (3.11) and response system (3.15) at fractional order $q = 0.95$ ; (a) with uncertain term; and (b) without uncertain term.	98
<b>Figure 4.1</b>	Phase portrait of the fractional order Chen system in $x_1 - x_2 - x_3$ space at the order $q = 0.96$ .	103
<b>Figure 4.2</b>	Phase portrait of the fractional order Qi system in $y_1 - y_2 - y_3$ space for the order of derivative $q = 0.96$ .	104
<b>Figure 4.3</b>	State trajectories of drive system (4.1) and response system (4.3) for fractional order $q = 0.96$ using active control method between: (a) $x_1$ and $y_1$ ; (b) $x_2$ and $y_2$ ; (c) $x_3$ and $y_3$ .	108
<b>Figure 4.4</b>	The evolution of the error functions $e_1(t)$ , $e_2(t)$ and $e_3(t)$ using active control method at: (a) $q = 0.92$ ; (b) $q = 0.96$ ; (c) $q = 1$ .	109
<b>Figure 4.5</b>	State trajectories of drive system (1) and response system (3) for fractional order $q = 0.96$ between: (a) $x_1$ and $y_1$ ; (b) $x_2$ and $y_2$ ; (c) $x_3$ and $y_3$ using backstepping method.	115
<b>Figure 4.6</b>	The evolution of the error functions $e_1(t)$ , $e_2(t)$ and $e_3(t)$ using backstepping method at: (a) $q = 0.92$ ; (b) $q = 0.96$ ; (c) $q = 1$ .	116

<b>Figure 5.1</b>	Phase portraits of (a) time-delay advanced Lorenz system, and (b) time-delay advanced Lorenz system with uncertainties and disturbances.	123
<b>Figure 5.2</b>	Phase portraits of (a) double time-delay Rossler system; (b) double time-delay Rossler system with uncertainties and external disturbances.	125
<b>Figure 5.3</b>	State trajectories of drive system (5.5) and response system (5.8) between: (a) $x_1(t)$ and $x_2(t)$ , (b) $y_1(t)$ and $y_2(t)$ , (c) $z_1(t)$ and $z_2(t)$ .	129
<b>Figure 5.4</b>	The evolution of the error functions $e_1(t)$ , $e_2(t)$ and $e_3(t)$ .	129
<b>Figure 6.1</b>	Phase portraits of the complex Lorenz system in (a) $x_{11} - x_{12} - x_{15}$ space, and (b) $x_{12} - x_{13} - x_{14}$ space.	138
<b>Figure 6.2</b>	Phase portraits of the complex Lu system in (a) $x_{21} - x_{22} - x_{25}$ space, and (b) $x_{22} - x_{23} - x_{24}$ space.	140
<b>Figure 6.3</b>	Phase portraits of the complex T system in (a) $y_{11} - y_{12} - y_{15}$ space, and (b) $y_{12} - y_{13} - y_{14}$ spaces.	142
<b>Figure 6.4</b>	Phase portraits of the complex Chen system in (a) $y_{21} - y_{22} - y_{25}$ space, and (b) $y_{22} - y_{23} - y_{24}$ space.	144
<b>Figure 6.5</b>	Phase portraits of the complex two coupled system in (a) $z_{11} - z_{12} - z_{15}$ space, and (b) $z_{12} - z_{13} - z_{14}$ space.	146
<b>Figure 6.6</b>	Phase portraits of the nonlinear complex chaotic system in (a) $z_{21} - z_{22} - z_{25}$ , and (b) $z_{22} - z_{23} - z_{24}$ spaces.	148

- Figure 6.7** State trajectories of the complex chaotic systems (6.15), (6.17), (6.19), (6.21), (6.26) and (6.27) between : (a)  $x_{11}(t) + y_{11}(t)$  and  $z_{11}(t)$ ; (b)  $x_{12}(t) + y_{12}(t)$  and  $z_{12}(t)$ ; (c)  $x_{13}(t) + y_{13}(t)$  and  $z_{13}(t)$ ; (d)  $x_{14}(t) + y_{14}(t)$  and  $z_{14}(t)$ ; (e)  $x_{15}(t) + y_{15}(t)$  and  $z_{15}(t)$ ; (f)  $x_{21}(t) + y_{21}(t)$  and  $z_{21}(t)$ ; (g)  $x_{22}(t) + y_{22}(t)$  and  $z_{22}(t)$ ; (h)  $x_{23}(t) + y_{23}(t)$  and  $z_{23}(t)$ ; (i)  $x_{24}(t) + y_{24}(t)$  and  $z_{24}(t)$ ; (j)  $x_{25}(t) + y_{25}(t)$  and  $z_{25}(t)$ . 155
- Figure 6.8** The plot for the evaluation of error functions  $e_{ij}(t)$ ,  $i = 1, 2$ ;  $j = 1, 2, \dots, 5$ . 156
- Figure 7.1** Phase portraits of the complex Lorenz system for the order of derivative  $q = 0.95$  in (a)  $x_{11} - x_{12} - x_{13}$  space, (b)  $x_{11} - x_{12} - x_{14}$  space, (c)  $x_{11} - x_{12} - x_{15}$  space, (d)  $x_{12} - x_{13} - x_{14}$  space, (e)  $x_{12} - x_{13} - x_{15}$  space, (f)  $x_{13} - x_{14} - x_{15}$  space. 171
- Figure 7.2** Phase portraits of the complex T system for the order of derivative  $q = 0.94$  in (a)  $x_{21} - x_{22} - x_{23}$  space, (b)  $x_{21} - x_{22} - x_{24}$  space, (c)  $x_{21} - x_{22} - x_{25}$  space, (d)  $x_{22} - x_{23} - x_{24}$  space, (e)  $x_{22} - x_{23} - x_{25}$  space, (f)  $x_{23} - x_{24} - x_{25}$  space. 175
- Figure 7.3** Dual combination synchronization of complex chaotic systems (7.14), (7.16)-(7.20) at  $q = 0.95$  between: (a)  $x_{11}(t) + y_{11}(t)$  and  $z_{11}(t)$ ; (b)  $x_{12}(t) + y_{12}(t)$  and  $z_{12}(t)$ ; (c)  $x_{13}(t) + y_{13}(t)$  and  $z_{13}(t)$ ; (d)  $x_{14}(t) + y_{14}(t)$  and  $z_{14}(t)$ ; (e)  $x_{15}(t) + y_{15}(t)$  and  $z_{15}(t)$ ; (f)  $x_{21}(t) + y_{21}(t)$  and  $z_{21}(t)$ ; (g)  $x_{22}(t) + y_{22}(t)$  and  $z_{22}(t)$ ; (h)  $x_{23}(t) + y_{23}(t)$  and  $z_{23}(t)$ ; (i)  $x_{24}(t) + y_{24}(t)$  and 182

$z_{24}(t)$ ; (j)  $x_{25}(t) + y_{25}(t)$  and  $z_{25}(t)$ .

**Figure 7.4** The evaluation of error functions  $e_{ij}(t)$ ,  $i = 1, 2$ ;  $j = 1, 2, \dots, 5$  at 183  
 $q = 0.95$ .

**Figure 7.5** The evaluation of error functions  $e_{ij}(t)$ ,  $i = 1, 2$ ;  $j = 1, 2, \dots, 5$  at 184  
 $q = 1$ .