Theorem 3.1.1. *The equilibrium point* $E_1 = (0,0,0)$ *is asymptotically stable if* $k_{11} = 0$, $k_{33} > 0$ *and* $k_{22} > 3c$.

3.1.2. Stability of the equilibrium point $E_2 = (\beta, \beta, \gamma)$

In this case $E = E_2$ and the controlled system (3.1) is in the form of

$$\begin{aligned} \dot{x} &= a(y-x) - k_{11}(x-\beta), \\ \dot{y} &= (c-a)x - xz + cy - k_{22}(y-\beta), \\ \dot{z} &= xy - bz + dx^2 - k_{33}(z-\gamma). \end{aligned} \tag{3.3}$$

Theorem 3.1.2. *The equilibrium point* $E_2 = (\beta, \beta, \gamma)$ *is asymptotically stable if* $k_{11}, k_{33} > 0$ *and* $k_{22} > 2c$.

3.1.3. Stability of the equilibrium point $E_3 = (-\beta, -\beta, \gamma)$

In this case $E = E_3$ and the controlled system (3.1) is in the form of

$$\begin{aligned} \dot{x} &= a(y-x) - k_{11}(x+\beta), \\ \dot{y} &= (c-a)x - xz + cy - k_{22}(y+\beta), \\ \dot{z} &= xy - bz + dx^2 - k_{33}(z-\gamma). \end{aligned} \tag{3.4}$$

Theorem 3.1.3. *The equilibrium point* $E_3 = (-\beta, -\beta, \gamma)$ *is asymptotically stable if* $k_{11}, k_{33} > 0$ *and* $k_{22} > 2c$.

3.1.4. Numerical simulation

Numerical experiments are carried out to investigate controlled systems by using fourth-order Runge–Kutta method with time step 0.001. The parameters a, b, c and d are chosen as $a = 35$, $b = 3$, $c = 28$ and $d = 2$ to ensure the existence of chaos in the absence of control. The initial states are taken as $x = 0.1$, $y = 0.2$ and $z = 0.3$. The control is active at $t = 10$. The equilibrium point $E_1 = (0,0,0)$ of the system (1.1) is stabilized for $k_{11} = 0$, $k_{22} = 85$ and $k_{33} = 5$. Fig. 1 show the behavior of the states x, y and z of the controlled system (3.2) with time. The equilibrium point $E_2 = (\sqrt{21}, \sqrt{21}, 21)$ of the system (1.1) is stabilized for $k_{11} = 1$, $k_{22} = 60$ and $k_{33} = 5$. Fig. 2 show the behavior of the states x, y and z of the controlled system (3.3) with time. The equilibrium point $E_3 = (-\sqrt{21}, -\sqrt{21}, 21)$ of the system (1.1) is stabilized for $k_{11} = 1$, $k_{22} = 60$ and $k_{33} = 5$. Fig. 3 shows the behavior of the states x, y and z of the controlled system (3.4) with time.

3.2. Bounded feedback control

In this case, we control chaos with bounded controller that vanishes after the stabilization is achieved.

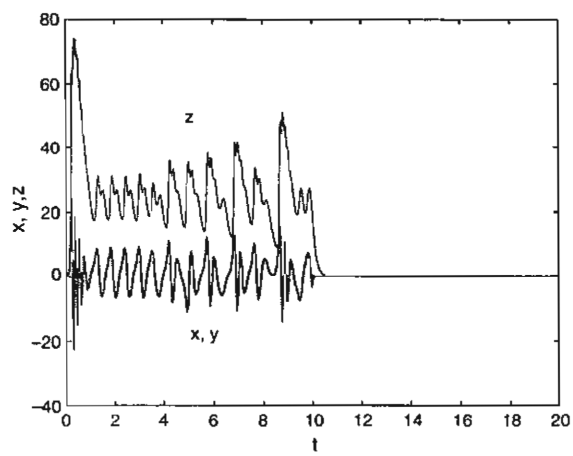

Fig. 1. The time responses for the states x, y and z of the controlled system (3.2) before and after control activation with time. The control is activated at $t = 10$, $k_{11} = 0$, $k_{22} = 85$ and $k_{33} = 5$.

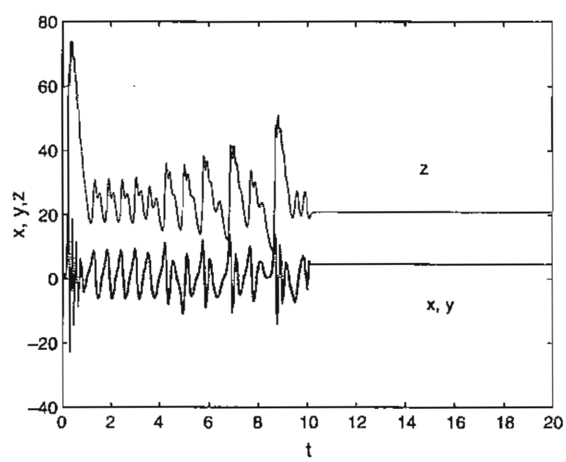

Fig. 2. The time responses for the states x, y and z of the controlled system (3.3) before and after control activation with time. The control is activated at $t = 10$, $k_{11} = 1$, $k_{22} = 60$ and $k_{33} = 5$.

3.2.1. Stability of the equilibrium point $E_I = (0, 0, 0)$

In order to stabilize this equilibrium point by bounded feedback control, the control is chosen for system (1.1) as follows:

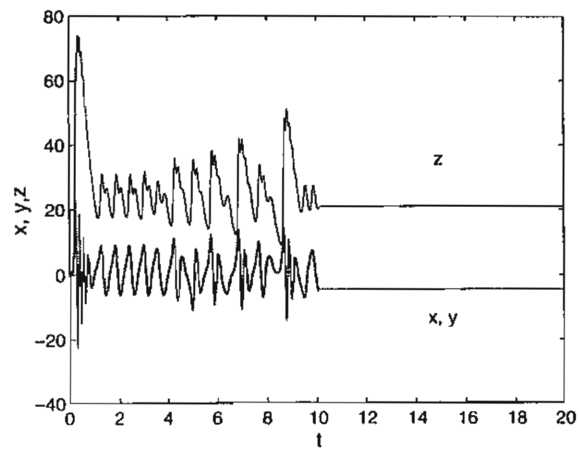

Fig. 3. The time responses for the states x, y and z of the controlled system (3.4) before and after control activation with time. The control is activated at $t = 10$, $k_{11} = 1$, $k_{22} = 60$ and $k_{33} = 5$.

$$\begin{aligned} \dot{x} &= a(y - x), \\ \dot{y} &= (c - a)x - xz + cy + u(t), \\ \dot{z} &= xy - bz + dx^2, \end{aligned} \tag{3.5}$$

where $u(t) = -k(a(x + y))$, $k > 0$.

Theorem 3.2.1. *The equilibrium point* $E_1 = (0, 0, 0)$ *is asymptotically stable if* $k > \frac{2c}{a}$.

3.2.2. Stability of the equilibrium point $E_2 = (\beta, \beta, \gamma)$

In order to stabilize this equilibrium point by bounded feedback control, the control is chosen for system (1.1) as follows:

$$\begin{aligned} \dot{x} &= a(y - x), \\ \dot{y} &= (c - a)x - xz + cy + u(t), \\ \dot{z} &= xy - bz + dx^2, \end{aligned} \tag{3.6}$$

where $u(t) = -k(a(y - x))$, $k > 0$.

Theorem 3.2.2. *The equilibrium point* $E_2 = (\beta, \beta, \gamma)$ *is asymptotically stable if* $k > \sqrt{2}$.

3.2.3. Stability of the equilibrium point $E_3 = (-\beta, -\beta, \gamma)$

In order to stabilize this equilibrium point by bounded feedback control, the control is chosen for system (1.1) as follows:

$$\begin{aligned} \dot{x} &= a(y-x), \\ \dot{y} &= (c-a)x - xz + cy + u(t), \\ \dot{z} &= xy - bz + dx^2, \end{aligned} \tag{3.7}$$

where $u(t) = -k(a(y-x))$, $k > 0$.

Theorem 3.2.3. *The equilibrium point $E_3 = (-\beta, -\beta, \gamma)$ is asymptotically stable if $k > \sqrt{2}$.*

3.2.4. Numerical simulation

We will show a series of numerical experiments by using the fourth-order Runge–Kutta method with step size 0.001. The parameters a, b, c and d are chosen as $a = 35$, $b = 3$, $c = 28$ and $d = 2$ to ensure the existence of chaos in the absence of control. The control is active at $t = 10$ for all simulations. In the first numerical experiment, we intend to control the chaos to equilibrium point $E_1 = (0,0,0)$ of system (1.1). Figs. 4–6 show the time response of the states x, y and z of system (3.5) and the controller $u(t)$ with time for $k = 1.6$. The initial condition are $x = 0.1$, $y = 0.2$ and $z = 0.3$. In the second numerical experiment, we intend to control the chaos to equilibrium point

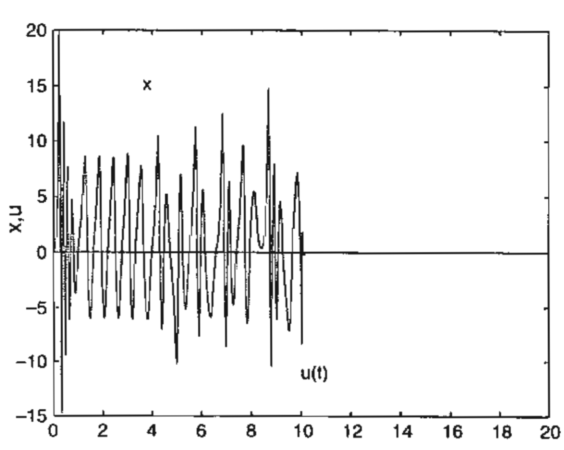

Fig. 4. The states x of the controlled system (3.5) and the control $u(t)$ respond with time before and after control activation. The control is activated at $t = 10$, $k = 1.6$.

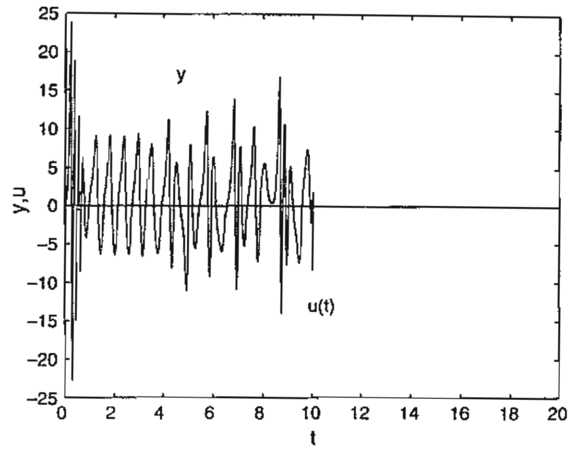

Fig. 5. The states y of the controlled system (3.5) and the control $u(t)$ respond with time before and after control activation. The control is activated at $t = 10$, $k = 1.6$.

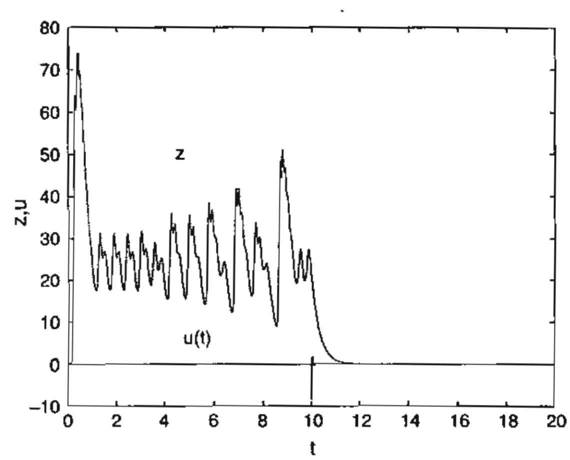

Fig. 6. The states z of the controlled system (3.5) and the control $u(t)$ respond with time before and after control activation. The control is activated at $t = 10$, $k = 1.6$.

$E_2 = (\sqrt{21}, \sqrt{21}, 21)$ of system (1.1). Figs. 7–9 show the time response of the states x, y and z of system (3.6) and the controller $u(t)$ with time for $k = 2$. The initial condition are $x = -2.5$, $y = -2.5$ and $z = 3$. In the third numerical experiment, we intend to control the chaos to equilibrium point $E_3 = (-\sqrt{21}, -\sqrt{21}, 21)$ of system (1.1). Fig. 10–12 show the time response of the states x, y and z of system (3.7) and the controller $u(t)$ with time for $k = 2$. The initial condition are $x = 2.5$, $y = 2.5$ and $z = 3$.

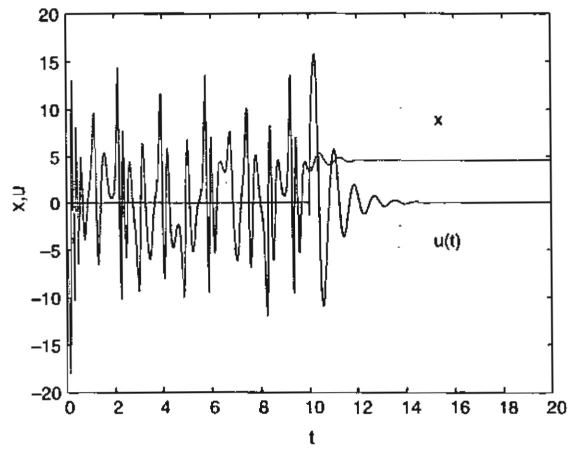

Fig. 7. The states x of the controlled system (3.6) and the control $u(t)$ respond with time before and after control activation. The control is activated at $t = 10$, $k = 2$.

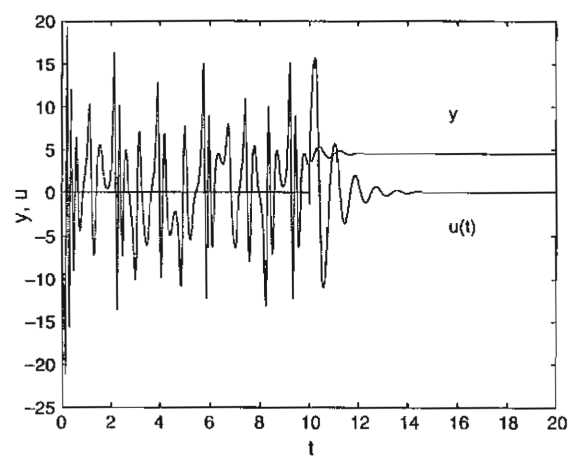

Fig. 8. The states y of the controlled system (3.6) and the control $u(t)$ respond with time before and after control activation. The control is activated at $t = 10$, $k = 2$.

4. Synchronization

To begin with, the definition of chaos synchronization is given as follows. For two nonlinear chaotic system:

$$\dot{x} = f(t, x), \tag{4.1}$$

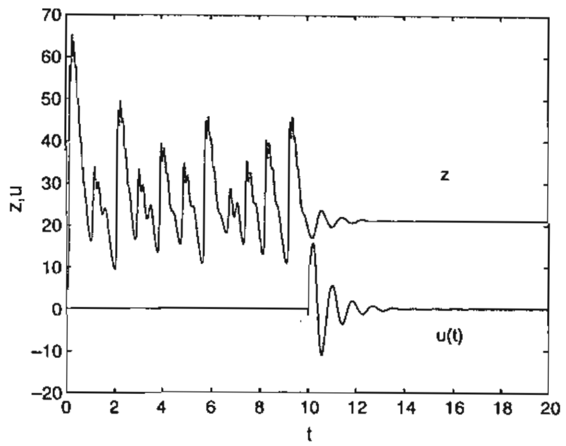

Fig. 9. The states z of the controlled system (3.6) and the control $u(t)$ respond with time before and after control activation. The control is activated at $t = 10$, $k = 2$.

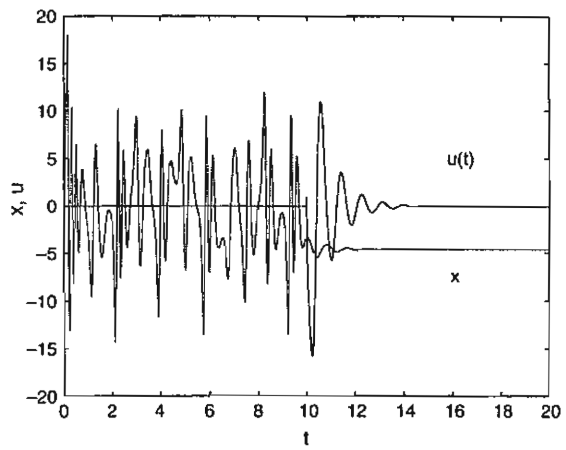

Fig. 10. The states x of the controlled system (3.7) and the control $u(t)$ respond with time before and after control activation. The control is activated at $t = 10$, $k = 2$.

$$\dot{y} = g(t, y) + u(t, x, y), \tag{4.2}$$

where $x, y \in \mathbb{R}^n, f, g \in C^r[\mathbb{R}^+ \times \mathbb{R}^n, \mathbb{R}^n]$, $u \in C^r[\mathbb{R}^+ \times \mathbb{R}^n \times \mathbb{R}^n, \mathbb{R}^n]$, $r \geqslant 1$, $\mathbb{R}^+$ is the set of non-negative real numbers. Assume that (4.1) is the drive system, and (4.2) is the response system, $u(t, x, y)$ is the control vector. Response system and drive system are said to be *synchronic* if for $\forall x(t_0)$, $y(t_0) \in \mathbb{R}^n$,

$$\lim_{t\to\infty} \|x(t) - y(t)\| = 0.$$

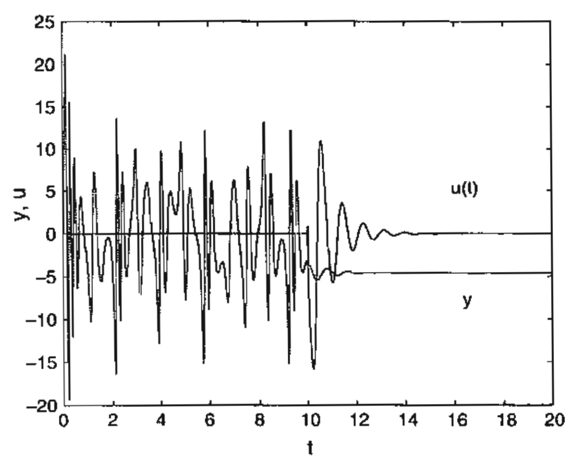

Fig. 11. The states y of the controlled system (3.7) and the control $u(t)$ respond with time before and after control activation. The control is activated at $t = 10$, $k = 2$.

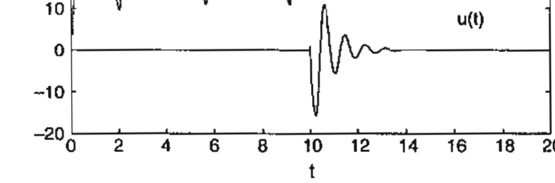

Fig. 12. The states z of the controlled system (3.7) and the control $u(t)$ respond with time before and after control activation. The control is activated at $t = 10$, $k = 2$.

4.1. Active control

In this section, we will give some particular active control which ensures synchronization of drive system and response system of perturbed Chen chaotic dynamical system. System (1.1) has chaotic behavior at the parameters values

$a = 35$, $b = 3$, $c = 28$ and $d = 2$. Our aim is to make synchronization of system (1.1) by using active control. The drive system is defined as follows,

$$\begin{aligned}
\dot{x}_1 &= a(y_1 - x_1),\\
\dot{y}_1 &= (c - a)x_1 - x_1 z_1 + c y_1,\\
\dot{z}_1 &= x_1 y_1 - b z_1 + d x_1^2
\end{aligned} \tag{4.3}$$

and the response system is given by

$$\begin{aligned}
\dot{x}_2 &= a(y_2 - x_2) + \mu_1(t),\\
\dot{y}_2 &= (c - a)x_2 - x_2 z_2 + c y_2 + \mu_2(t),\\
\dot{z}_2 &= x_2 y_2 - b z_2 + d x_2^2 + \mu_3(t).
\end{aligned} \tag{4.4}$$

We have introduced three control functions $\mu_1(t)$,$\mu_2(t)$ and $\mu_3(t)$ in (4.4). These functions are to be determined. Let the error states be

$$\begin{aligned}
x_3 &= x_2 - x_1,\\
y_3 &= y_2 - y_1,\\
z_3 &= z_2 - z_1.
\end{aligned}$$

Using this notation, we obtain the error system.

$$\begin{aligned}
\dot{x}_3 &= a(y_3 - x_3) + \mu_1(t),\\
\dot{y}_3 &= (c - a)x_3 + c y_3 - x_2 z_2 + x_1 z_1 + \mu_2(t),\\
\dot{z}_3 &= -b z_3 - x_1 y_1 + x_2 y_2 + d x_2^2 - d x_1^2 + \mu_3(t).
\end{aligned} \tag{4.5}$$

We define the active control functions $\mu_1(t)$, $\mu_2(t)$ and $\mu_3(t)$ as

$$\begin{aligned}
\mu_1(t) &= V_1(t),\\
\mu_2(t) &= x_2 z_2 - x_1 z_1 + V_2(t),\\
\mu_3(t) &= x_1 y_1 - x_2 y_2 - d x_2^2 + d x_1^2 + V_3(t).
\end{aligned} \tag{4.6}$$

Hence,

$$\begin{aligned}
\dot{x}_3 &= a(y_3 - x_3) + V_1(t),\\
\dot{y}_3 &= (c - a)x_3 + c y_3 + V_2(t),\\
\dot{z}_3 &= -b z_3 + V_3(t).
\end{aligned} \tag{4.7}$$

The control inputs $V_1(t)$, $V_2(t)$ and $V_3(t)$ are functions of x_3, y_3 and z_3 and are chosen as

$$\begin{bmatrix} V_1(t) \\ V_2(t) \\ V_3(t) \end{bmatrix} = A \begin{bmatrix} x_3 \\ y_3 \\ z_3 \end{bmatrix}, \tag{4.8}$$

where the matrix A is given by

$$A = \begin{bmatrix} a-1 & -a & 0 \\ a-c & -(1+c) & 0 \\ 0 & 0 & b-1 \end{bmatrix}.$$

With this particular choice of A, (4.7) has eigenvalues which are found to be -1, -1 and -1. The choice will lead to the error states x_3, y_3 and z_3 converge to zero as time t tends to infinity and this implies that the synchronization of perturbed Chen system is achieved.

4.1.1. Numerical simulation

Fourth-order Runge–Kutta method of differential equations (4.3) and (4.4) with time step size 0.001 are used in all numerical simulations.

The parameters are selected in (4.3) as follow: $a = 35$, $b = 3$, $c = 28$ and $d = 2$ to ensure the chaotic behavior of perturbed Chen system. The initial value of the drive system are $x_1(0) = 0.5$, $y_1(0) = 1$ and $z_1(0) = 1$ and the initial value of the response system are $x_2(0) = 10.5$, $y_2(0) = 1$ and $z_2(0) = 38$. Then the initial value of the error system are $x_3(0) = 10$, $y_3(0) = 0$ and $z_3(0) = 37$.

Figs. 13–15 show the synchronization is occurred after applying active control at $t = 5$.

4.2. Adaptive control

This section considers adaptive synchronization of perturbed Chen system. This approach can synchronize the chaotic systems with fully unmatched

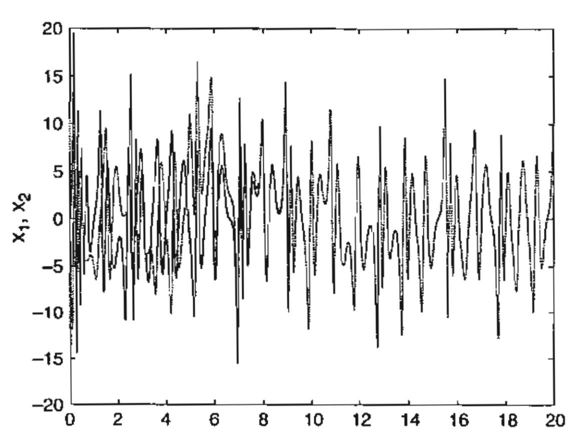

Fig. 13. The states x_1, x_2 of the coupled perturbed Chen system of equations with the active control activated.

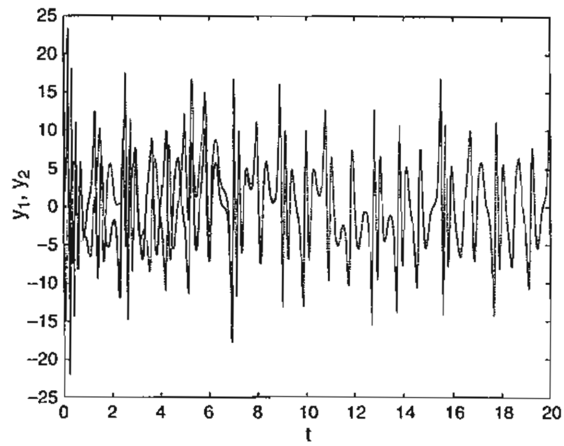

Fig. 14. The states y_1, y_2 of the coupled perturbed Chen system of equations with the active control activated.

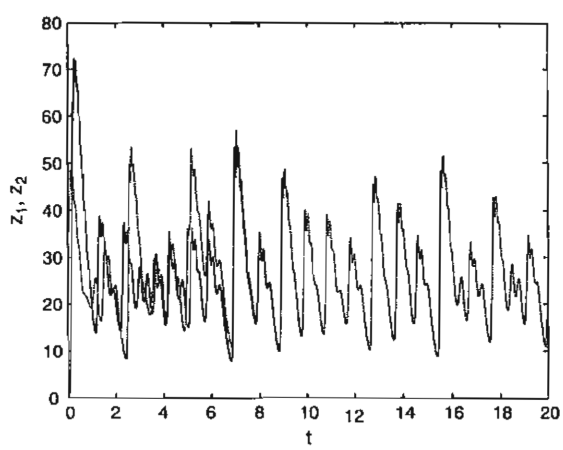

Fig. 15. The states z_1, z_2 of the coupled perturbed Chen system of equations with the active control activated.

parameters. The synchronization problem of perturbed Chen systems with fully unknown parameters will be studied in which the adaptive controller will be introduced.

Let system (1.1) be the drive system. Suppose that the parameters of the system (1.1) are unknown or uncertain, then the response system is given by

$$
\begin{aligned}
\dot{\tilde{x}} &= \hat{a}(\tilde{y}-\tilde{x}) - u_1,\\
\dot{\tilde{y}} &= (\hat{c}-\hat{a})\tilde{x} - \tilde{x}\tilde{z} + \hat{c}\tilde{y} - u_2,\\
\dot{\tilde{z}} &= \tilde{x}\tilde{y} - \hat{b}\tilde{z} + \hat{d}\tilde{x}^2 - u_3,
\end{aligned}
\tag{4.9}
$$

where $\hat{a}, \hat{b}, \hat{c}$ and $\hat{d}$ are parameters of the response system which need to be estimated. Suppose that

$$
\begin{aligned}
u_1 &= k_1 e_x,\\
u_2 &= k_2 e_y,\\
u_3 &= k_3 e_z + d\tilde{x}e_x,
\end{aligned}
\tag{4.10}
$$

where $e_x = \tilde{x} - x$, $e_y = \tilde{y} - y$ and $e_z = \tilde{z} - z$ and

$$
\begin{aligned}
\dot{\hat{a}} &= f_a = -\gamma(\tilde{y}-\tilde{x})\rho e_x + \gamma\tilde{x}e_y,\\
\dot{\hat{b}} &= f_b = \theta\tilde{z}e_z,\\
\dot{\hat{c}} &= f_c = -\beta(\tilde{x}+\tilde{y})e_y,\\
\dot{\hat{d}} &= f_d = -\delta\tilde{x}^2 e_z,
\end{aligned}
\tag{4.11}
$$

where $k_1, k_2, k_3 \geqslant 0$ and $\rho, \gamma, \theta, \beta, \delta > 0$ are constants.

Theorem 4.2.1. *Suppose that $M_{C_x} > |x|, M_{C_y} > |y|, M_{C_z} > |z|$, $\rho, \gamma, \theta, \beta, \delta$ are positive constants. When k_1, k_2 and $k_3 \geqslant 0$ are properly chosen such that the following matrix inequality holds,*

$$
P = \begin{bmatrix}
\rho(k_1+a) & -\frac{1}{2}(\rho a - a + c + M_{C_z}) & -\frac{1}{2}(M_{C_y} + dM_{C_x})\\
-\frac{1}{2}(\rho a - a + c + M_{C_z}) & k_2 - c & 0\\
-\frac{1}{2}(M_{C_y} + dM_{C_x}) & 0 & k_3 + b
\end{bmatrix} > 0
\tag{4.12}
$$

or equivalently if k_1, k_2 and k_3 are chosen so that the following inequalities hold:

$$
\begin{aligned}
&\text{(i) } A = \rho(k_1+a)(k_2-c) - \frac{1}{4}(\rho a - a + c + M_{C_z})^2 > 0,\\
&\text{(ii) } B = A(k_3+b) - \frac{1}{4}(M_{C_y} + dM_{C_x})^2(k_2-c) > 0
\end{aligned}
\tag{4.13}
$$

then the two perturbed Chen systems (1.1) *and* (4.9) *can be synchronized under the adaptive control of* (4.10) *and* (4.11).

Proof. It is easy to see from (1.1) and (4.9) that the error dynamics can be obtained as follow

$$\begin{aligned}
\dot{e}_x &= \hat{a}(\tilde{y}-\tilde{x}) - a(y-x) - u_1,\\
\dot{e}_y &= -\hat{a}\tilde{x} + ax + \hat{c}\tilde{x} - cx + \hat{c}\tilde{y} - cy - \tilde{x}\tilde{z} + xz - u_2,\\
\dot{e}_z &= -\hat{b}\tilde{z} + bz + \tilde{x}\tilde{y} - xy - u_3.
\end{aligned} \tag{4.14}$$

Let $e_a = \hat{a} - a$, $e_b = \hat{b} - b$, $e_c = \hat{c} - c$, $e_d = \hat{d} - d$. Choose the following Lyapunov function:

$$V(e_x, e_y, e_z) = \frac{1}{2}\left(\rho e_x^2 + e_y^2 + e_z^2 + \frac{1}{\gamma}e_a^2 + \frac{1}{\theta}e_b^2 + \frac{1}{\beta}e_c^2 + \frac{1}{\delta}e_d^2\right) \tag{4.15}$$

in which the differentiation of V along trajectories of (4.14) gives

$$\begin{aligned}
\dot{V} &= \rho e_x\dot{e}_x + e_y\dot{e}_y + e_z\dot{e}_z + \frac{1}{\gamma}e_a\dot{e}_a + \frac{1}{\theta}e_a\dot{e}_a + \frac{1}{\beta}e_b\dot{e}_b + \frac{1}{\delta}e_d\dot{e}_d\\
&= \rho e_x[\hat{a}(\tilde{y}-\tilde{x}) - a(y-x) - u_1] + e_y[-\hat{a}\tilde{x} + ax + \hat{c}\tilde{x} - cx + \hat{c}\tilde{y} - cy - \tilde{x}\tilde{z} + xz - u_2]\\
&\quad + e_z[-\hat{b}\tilde{z} + bz + \tilde{x}\tilde{y} - xy - u_3] + \frac{1}{\gamma}e_af_a + \frac{1}{\theta}e_bf_b + \frac{1}{\beta}e_cf_c + \frac{1}{\delta}e_df_d\\
&= [\rho\hat{a}(\tilde{y}-\tilde{x}) - \rho a(\tilde{y}-\tilde{x}) + \rho a(\tilde{y}-\tilde{x}) - \rho a(y-x)]e_x - \rho u_1e_x\\
&\quad + [-\hat{a}\tilde{x} + a\tilde{x} - a\tilde{x} + ax]e_y + [-\tilde{x}\tilde{z} + \tilde{x}z - \tilde{x}z + xz]e_y - u_2e_y\\
&\quad + [\hat{c}(\tilde{x}+\tilde{y}) - c(\tilde{x}+\tilde{y}) + c(\tilde{x}+\tilde{y}) - c(x+y)]e_y\\
&\quad + [-\hat{b}\tilde{z} + b\tilde{z} - b\tilde{z} + bz]e_z + [\tilde{x}\tilde{y} - \tilde{x}y + \tilde{x}y - xy]e_z\\
&\quad + [\hat{d}\tilde{x}^2 - d\tilde{x}^2 + d\tilde{x}^2 - dx^2]e_z - u_3e_z + \frac{1}{\gamma}e_af_a + \frac{1}{\theta}e_bf_b + \frac{1}{\beta}e_cf_c + \frac{1}{\delta}e_dfd\\
&= \rho(\tilde{y}-\tilde{x})e_ae_x + \rho a(e_y-e_x)e_x - \rho u_1e_x - \tilde{x}e_ae_y - ae_xe_y - \tilde{x}e_ye_z - ze_xe_y - u_2e_y\\
&\quad + e_ce_y(\tilde{x}+\tilde{y}) + c(e_x+e_y)e_y - \tilde{z}e_be_z - be_z^2 + \tilde{x}e_ye_z + ye_xe_z\\
&\quad + \tilde{x}^2e_de_z + de_xe_z(\tilde{x}+x) - u_3e_z + \frac{1}{\gamma}e_af_a + \frac{1}{\theta}e_bf_b + \frac{1}{\beta}e_cf_c + \frac{1}{\delta}e_df_d\\
&= \rho(\tilde{y}-\tilde{x})e_ae_x + \rho a(e_y-e_x)e_x - \rho k_1e_x^2 - \tilde{x}e_ae_y - ae_xe_y - \tilde{x}e_ye_z - ze_xe_y - k_2e_y^2\\
&\quad + e_ce_y(\tilde{x}+\tilde{y}) + c(e_x+e_y)e_y - \tilde{z}e_be_z - be_z^2 + \tilde{x}e_ye_z + ye_xe_z + \tilde{x}^2e_de_z\\
&\quad + de_xe_z(\tilde{x}+x) - (k_3e_z + d\tilde{x}e_x)e_z + \frac{1}{\gamma}e_af_a + \frac{1}{\theta}e_bf_b + \frac{1}{\beta}e_cf_c + \frac{1}{\delta}e_df_d\\
&= -\rho(k_1+a)e_x^2 - (k_2-c)e_y^2 - (k_3+b)e_z^2 + (\rho a + c - a - z)e_xe_y + (y+xd)e_xe_z\\
&\quad + e_a\left[\frac{1}{\gamma}f_a + (\tilde{y}-\tilde{x})\rho e_x - \tilde{x}e_y\right] + e_b\left[\frac{1}{\theta}f_b - \tilde{z}e_z\right]\\
&\quad + e_c\left[\frac{1}{\beta}f_c + (\tilde{x}+\tilde{y})e_y\right]e_d\left[\frac{1}{\delta}f_d + \tilde{x}^2e_z\right]\\
&< -\rho(k_1+a)e_x^2 - (k_2-c)e_y^2 - (k_3+b)e_z^2 + (\rho a + c - a - M_{C_z})|e_xe_y|\\
&\quad + (M_{C_y} + dM_{C_x})|e_xe_z| = -e^TPe,
\end{aligned}$$

where $e = [\,|e_x| \quad |e_y| \quad |e_z|\,]^T$, P is as in (4.12). Thus the differentiation of $V(e_x, e_y, e_z)$ is negative definite, which implies that the origin of error system (4.14) is asymptotically stable. Therefore, the response system (4.9) is synchronizing with the drive system (1.1). □

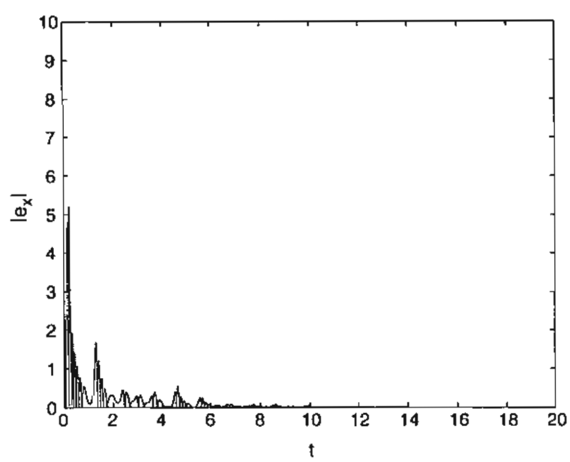

Fig. 16. Synchronization errors: $|e_x|$.

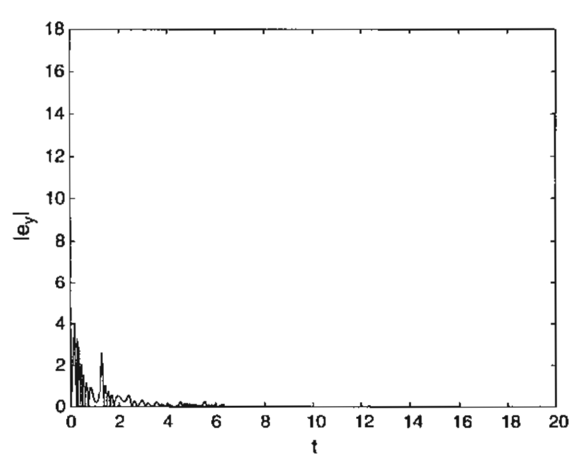

Fig. 17. Synchronization errors: $|e_y|$.

4.2.1. Numerical simulation

The numerical simulations are carried out using the fourth-order Runge–Kutta method. The initial conditions of the drive and response systems are (0.5, 1, 5) and (10.5, 20, 38). The parameters of the drive system are $a = 35$, $b = 3$, $c = 28$ and $d = 2$.

In order to choose the control parameters, $M_{C_x} > |x|$, $M_{C_y} > |y|$ and $M_{C_z} > |z|$ must be estimated. Through simulations, we obtain $M_{C_x} \approx 20$,

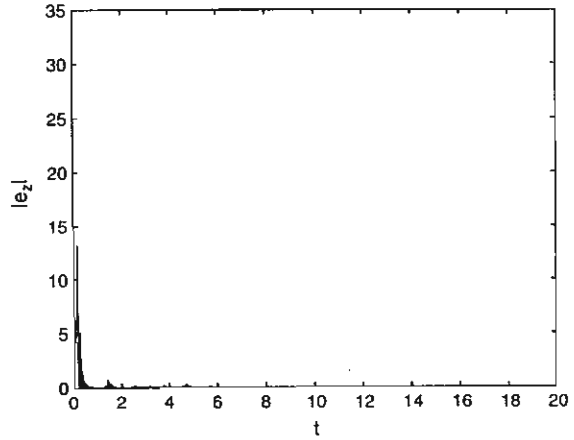

Fig. 18. Synchronization errors: $|e_z|$.

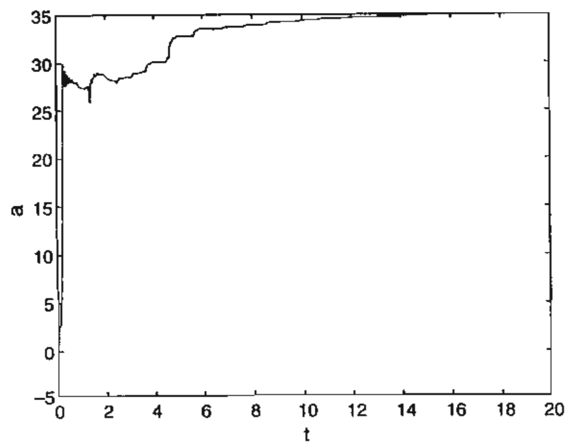

Fig. 19. Changing parameters: $\hat{a}$.

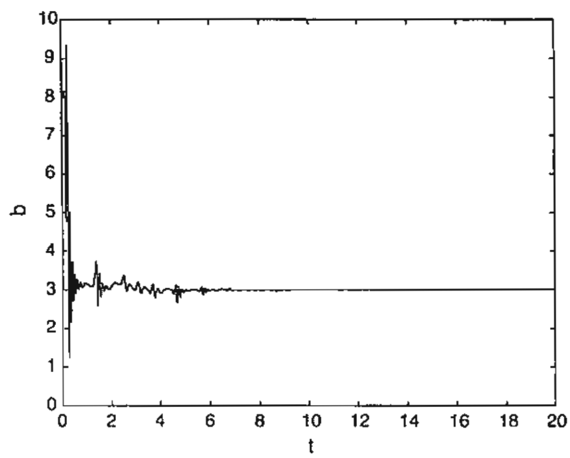

Fig. 20. Changing parameters: $\hat{b}$.

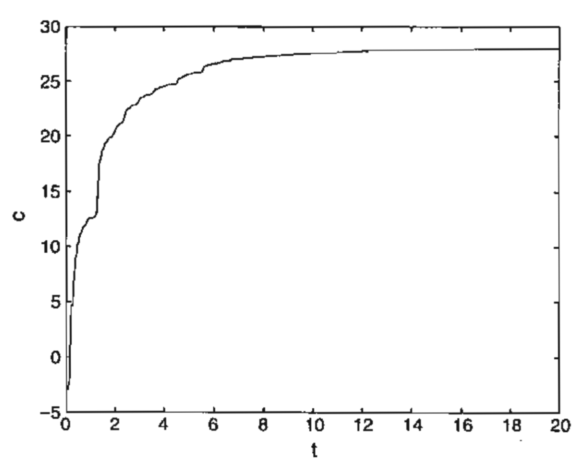

Fig. 21. Changing parameters: $\hat{c}$.

$M_{C_y} \approx 25$ and $M_{C_z} \approx 70$. Then we firstly choose $\rho = M_{C_y}^2/(ab)$. Then choose $\gamma = \theta = \beta = 1$ and then choose $k_1 = 25$, $k_2 = 88$, $k_3 = 50$ which satisfy (4.13) and the initial values of the parameters $\hat{a}, \hat{b}, \hat{c}$ and $\hat{d}$ are all chosen to be 0, the response system synchronizes with the drive system as shown in Figs. 16–18 and the changing parameters of $\hat{a}, \hat{b}, \hat{c}$ and $\hat{d}$ are shown in Figs. 19–22.

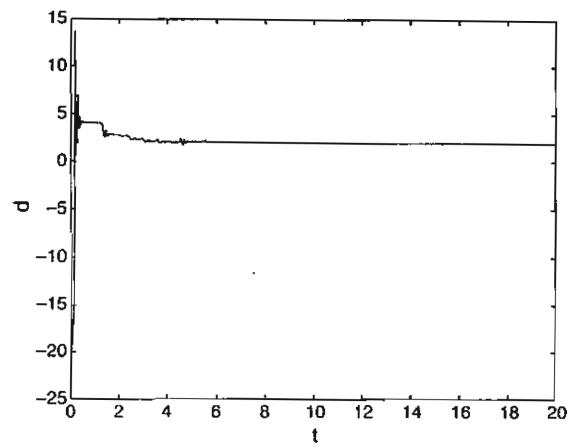

Fig. 22. Changing parameters: $\hat{d}$.

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Kyungpook Mathematical Journal
Department of Mathematics
College of Natural Sciences
Kyungpook National University
Daegu 702-701, Korea

Telephone +82-53-950-5312
FAX +82-53-950-6306
E-mail: kmj@knu.ac.kr
chnypark@knu.ac.kr
URL : http://kmj.knu.ac.kr/

REFEREE'S EVALUATION

Title of the paper : The Asymptotic Stability of $x_{n+1} - a^2 x_{n-1} + b x_{n-k} = 0$

KMJ number : KMJ 04103

Recommendation :

[ ] publication strongly recommended

[ ] publication recommended

[V] revised required

[ ] publication not recommended

For revised paper :

[ ] recommended changed carried out satisfactorily

[ ] recommended changed NOT carried out satisfactorily

==

See the attaching PDF file.

Evaluation report on **KMJ #04103**

The asymptotic stability of ...

P. Niamsup and Y. Lensury

I suggest few minor changes which might help the reader to better understand the present paper.

1. In the abstract, you just mention the topic paper – but you do not describe its content. A few words might been added, e. g.
   - that the conditions are *explicitly* stated in terms of the coefficients of the given equation and
   - a short remark about the methods of proof.

2. In the first line of the second page you announce that 'some properties of the Möbius transformation' will be used. However, neither the phrase 'Möbius transformation' does appear again at any other place in the paper nor could I find any place (notably in the proof of Lemma 2.5) where a property of Möbius transformations has been used. However, what I have found is that the paper heavily hings on arithmetic of complex numbers, polar coordinates and the (complex) sinus function.
   Therefore, I suggest that
   - either: if you make use of a property of a Möbius transformation you explicitly mention this in the prove at the place where you use it.
   - or: you replace that sentence by a more accurate description of your methods of proof (should be consistent with the remark to be added in the abstract).

3. Overall evaluation:
   - The result of the present paper is of interest.
   - All the proofs required some lengthy calculations which locally are not difficult (at least not difficult to check) but at the whole it isn't trivial.
   - The length is appropriate and all the necessary details of the proofs have been given. Any shortening might make it more difficult for any reader to understand the paper. No additions – beside the above mentioned ones – are needed.
   - Consequently, I do recommend the paper to be published at its full length.

M_r -FACTORS AND Q_r -FACTORS FOR NEAR QUASINORM ON CERTAIN SEQUENCE SPACES

PIYAPONG NIAMSUP AND YONGWIMON LENBURY

Received 15 July 2004 and in revised form 20 June 2005

We study the multiplicativity factor and quadraticity factor for near quasinorm on certain sequence spaces of Maddox, namely, $l(p)$ and $l_\infty(p)$, where $p = (p_k)$ is a bounded sequence of positive real numbers.

We changed "p","Q", and "M" from normal text to normal math. Please check such cases throughout.

We changed "QUASI-NORM" in the title to "QUASINORM." Please check.

1. Introduction

Let X be an algebra over a field F (R or C). A *quasinorm* on X is a function $|\cdot|: X \to R$ such that

(i) $|0| = 0$,
(ii) $|x| \geq 0$, for all $x \in X$,
(iii) $|-x| = |x|$, for all $x \in X$,
(iv) $|x+y| \leq |x| + |y|$, for all $x, y \in X$,
(v) if $t_k \in F$, $|t_k - t| \to 0$, and $x_k, x \in X$, $|x_k - x| \to 0$, then $|t_k x_k - tx| \to 0$.

If $|\cdot|$ satisfies only properties (i) to (iv), then we call $|\cdot|$ a *near quasinorm*. If the quasinorm satisfies $|x| = 0$ if and only if $x = 0$, then it is said to be *total*.

A *quasinormed linear space* (QNLS) is a pair $(X, |\cdot|)$ where $|\cdot|$ is a quasinorm on X. If $(X, |\cdot|)$ is a quasinorm space, then the map $|\cdot|: X \to R$ is continuous. For $p > 0$, a p -seminorm on X is a function $\|\cdot\|: X \to R$ satisfying

(i) $\|x\| \geq 0$, for all $x \in X$,
(ii) $\|tx\| = |t|^p \|x\|$, for all $t \in F$, for all $x \in X$,
(iii) $\|x+y\| \leq \|x\| + \|y\|$, for all $x, y \in X$.

A seminorm is called a norm if it satisfies the following condition:
(iv) $\|x\| = 0$ if and only if $x = 0$.

A p-seminormed linear space (p-semi-NLS) is a pair $(X, \|\cdot\|)$ where $\|\cdot\|$ is a seminorm on X. p-normed linear spaces (p-normed-LS) are defined similarly.

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2 M_r-factors and Q_r-factors

In [1, 2], *multiplicativity factors (or M -factors)* and *quadrativity factors (or Q -factors)* for seminorms on an algebra X have been introduced and studied in detail. A number $\mu > 0$ is said to be a multiplicativity factor for a seminorm S if and only if $S(xy) \le \mu S(x)S(y)$, for all $x, y \in X$. Similarly, a number $\lambda > 0$ is said to be a quadrativity factor for S if and only if $S(x^2) \le \lambda S(x)^2$, for all $x \in X$. The necessary and sufficient conditions for existence of M-factor and Q-factor for S are answered in the following results.

THEOREM 1.1. *Let X be an algebra and let $S \neq 0$ be a seminorm on X. Then*

(a) *S has M-factors on X if and only if* Ker S *is an ideal in X and*

$$\mu_{\inf} \equiv \sup\{S(xy) : x, y \in X,\ S(x) = S(y) = 1\} < +\infty, \tag{1.1}$$

(b) *if S has M-factors on X and $\mu_{\inf} > 0$, then $\mu_{\inf}$ is the best (least) M-factor for S,*

(c) *if S has M-factors on X and $\mu_{\inf} = 0$, then μ is an M-factor for S if and only if $\mu > 0$.*

THEOREM 1.2. *Let X be an algebra and let $S \neq 0$ be a seminorm on X. Then*

(a) *S has Q-factors on X if and only if* Ker S *is closed under squaring (i.e.,* $(\mathrm{Ker}\, S)^2 \subset \mathrm{Ker}\, S$*) and*

$$\lambda_{\inf} \equiv \sup\{S(x^2) : x \in X,\ S(x) = 1\} < +\infty, \tag{1.2}$$

(b) *if S has Q-factors on X and $\lambda_{\inf} > 0$, then $\lambda_{\inf}$ is the best (least) Q-factor for S,*

(c) *if S has Q-factors on X and $\lambda_{\inf} = 0$, then λ is a Q-factor for S if and only if $\lambda > 0$.*

If S is a norm, then $\mathrm{Ker}\, S = \{0\}$. If in addition X is finite-dimensional, then a simple compactness argument shows that $\mu_{\inf}$ is finite. Therefore, by Theorem 1.1, norms on finite-dimensional algebras always have M-factors. If S is a seminorm on a finite-dimensional algebra X, then S has M-factors on X if and only if $\mathrm{Ker}\, S$ is a (two-sided) ideal in X. In [1, 2] several examples of seminorms having M-factors and Q-factors are given. In [3], scalar multiplicativity factors for near quasinorms on certain sequence spaces of Maddox are studied. Motivated by these results we define *M_r-factors* and *Q_r-factors* for a near quasinorm q on an algebra X as follows.

A number $\mu > 0$ is an *M_r-factor* for q if and only if $q(txy) \le \mu |t|^r q(x)q(y)$, there exists $r > 0$, for all $t \in F$, for all $x, y \in X$.

A number $\lambda > 0$ is a *Q_r-factor* for q if and only if $q(tx^2) \le \lambda |t|^r q(x)^2$, there exists $r > 0$, for all $t \in F$, for all $x \in X$.

We changed "∃" to "there exists" twice. Please check.

Let

$$\begin{aligned} \mu_{\inf} &\equiv \sup\left\{\frac{q(txy)}{|t|^r q(x)q(y)} : t \in F - \{0\},\ x, y \in X - \mathrm{Ker}\, q\right\}, \\ \lambda_{\inf} &\equiv \sup\left\{\frac{q(tx^2)}{|t|^r q(x)^2} : t \in F - \{0\},\ x \in X - \mathrm{Ker}\, q\right\}. \end{aligned} \tag{1.3}$$

2. M_r-factors and Q_r-factors for near quasinorms

In this section we will prove the following theorems.

THEOREM 2.1. *Let X be an algebra over a field F ($F = C$ or R). Let q be a near quasinorm on X. Then*

(a) *q has M_r-factors on X if and only if* Ker q *is a (two-sided) ideal in X and $\mu_{\inf} < +\infty$,*
(b) *if q has M_r-factors on X and $\mu_{\inf} > 0$, then $\mu_{\inf}$ is the best (least) M_r- factor for q,*
(c) *if q has M_r-factors on X and $\mu_{\inf} = 0$, then μ is an M_r- factor for q if and only if $\mu > 0$.*

We changed "factors" to "factor." Please check similar highlighted cases throughout.

THEOREM 2.2. *Let X be an algebra over a field F ($F = C$ or R). Let q be a near quasinorm on X. Then*

(a) *q has Q_r-factors on X if and only if* Ker q *is closed under squaring (i.e., $x^2 \in$* Ker q*, for all $x \in$* Ker q*) and $\lambda_{\inf} < +\infty$,*
(b) *if q has Q_r-factors on X and $\lambda_{\inf} > 0$, then $\lambda_{\inf}$ is the best (least) Q_r-factors for q,*
(c) *if q has Q_r-factors on X and $\lambda_{\inf} = 0$, then λ is a Q_r-factors for q if and only if $\lambda > 0$.*

Proof of Theorem 2.1. (a) Suppose that q has an M_r-factor μ on X. Clearly, Ker q is a subspace of X. Now take any $x \in \operatorname{Ker} q$ and $y \in X$. Then $q(xy) \le \mu q(x)q(y) = 0$ which implies that $xy \in \operatorname{Ker} q$. Similarly, $yx \in \operatorname{Ker} q$, so Ker q is a (two-sided) ideal in X. Now for $t \in F - \{0\}$ and $x, y \in X - \operatorname{Ker} q$, we have $q(txy) \le \mu|t|^r q(x)q(y)$ or $q(txy)/|t|^r q(x)q(y) \le \mu$ which implies that $\mu_{\inf} \le \mu < +\infty$. Conversely, suppose that Ker q is a (two-sided) ideal in X and $\mu_{\inf} < +\infty$. If $t = 0$, $x \in \operatorname{Ker} q$, or $y \in \operatorname{Ker} q$, then $txy \in \operatorname{Ker} q$, so $0 = q(txy) = \mu_{\inf}|t|^r q(x)q(y)$. If $t \ne 0$ and $x, y \notin \operatorname{Ker} q$, then $q(txy)/|t|^r q(x)q(y) \le \mu_{\inf}$ or $q(txy) \le \mu_{\inf}|t|^r q(x)q(y)$. Therefore, $q(txy) \le \mu_{\inf}|t|^r q(x)q(y)$, for all $t \in F$ and for all $x, y \in X$ which implies that q has M_r-factors on X.

(b) Let μ be an M_r- factor for q on X and $\mu_{\inf} > 0$. Then $q(txy) \le \mu|t|^r q(x)q(y)$ for all $t \in F$ and for all $x, y \in X$. Therefore, $q(txy)/|t|^r q(x)q(y) \le \mu$, for all $t \in F - \{0\}$ and for all $x, y \in \operatorname{Ker} q$, so $\mu_{\inf} \le \mu$.

(c) This part follows directly from definition of $\mu_{\inf}$ and M_r-factors for q on X. □

Proof of Theorem 2.2. The proof of this theorem is a simple modification of the proof of Theorem 2.1 and will be omitted. □

3. M_r-factors and Q_r-factors for near quasinorm on certain sequence spaces of Maddox

Let $p = (p_k)$ be a bounded sequence of positive real numbers. The sequence spaces of Maddox $l_\infty(p)$ and $l(p)$ are defined as follows:

$$\begin{aligned} l_\infty(p) &= \left\{(x_k) : x_k \in C,\ \sup_k |x_k|^{p_k} < \infty\right\}, \\ l(p) &= \left\{(x_k) : x_k \in C,\ \sum_k |x_k|^{p_k} < \infty\right\}. \end{aligned} \tag{3.1}$$

4 M_r-factors and Q_r-factors

With the usual multiplication (i.e., $(x_k)(y_k) = (x_k y_k)$), both $l_\infty(p)$ and $l(p)$ are algebras over C. We define near quasinorms q_1 on $l_\infty(p)$ and q_2 on $l(p)$ as follows:

$$q_1((x_k)) = \sup_k |x_k|^{p_k/M}, \quad (x_k) \in l_\infty(p),$$
$$q_2((x_k)) = \left(\sum_k |x_k|^{p_k}\right)^{1/M}, \quad (x_k) \in l(p), \tag{3.2}$$

where $M = \max\{1, \sup_k p_k\}$. We observe that q_1 and q_2 may or may not be quasinorms. For example, when $(p_k) = (1/k)$, then q_1 is a near quasinorm but not a quasinorm; if $(p_k) = (1 - 1/(k+1))$, then q_1 is a quasinorm.

In this section we give necessary and sufficient conditions for sequence spaces $l_\infty(p)$ and $l(p)$ to have M_r-factors and Q_r-factors.

THEOREM 3.1. *Let $p = (p_k)$ and let M be defined as above. Then the following are equivalent.*

(a) *$p_0 = p_k = p_{k+1}$ for all $k \geq 0$ where p_0 is a positive real number.*
(b) *q_1 has M_r-factors on $l_\infty(p)$.*
(c) *q_1 has Q_r-factors on $l_\infty(p)$.*
(d) *q_1 is a p_0/M-seminorm on $l_\infty(p)$.*

THEOREM 3.2. *Let $p = (p_k)$ and let M be defined as above. Then the following are equivalent.*

(a) *$p_0 = p_k = p_{k+1}$ for all $k \geq 0$ where p_0 is a positive real number.*
(b) *q_2 has M_r-factors on $l(p)$.*
(c) *q_2 has Q_r-factors on $l(p)$.*
(d) *q_2 is a p_0/M-seminorm on $l(p)$.*

Proof of Theorem 3.1. (a)⇒(b) If $p_0 = p_k = p_{k+1}$ for all $k \geq 1$, then

$$q_1(txy) = \sup_k |txy|^{p_k/M} = \sup_k |txy|^{p_0/M} \leq |t|^{p_0/M} q_1(x) q_1(y) \tag{3.3}$$

for all $x, y \in l_\infty(p)$, so q_1 has an M_r-factor on $l_\infty(p)$.

(b)⇒(a) Assume that q_1 has M_r-factors on $l_\infty(p)$. This implies that

$$\mu_{\inf} = \sup\left\{\frac{q_1(txy)}{|t|^r q_1(x) q_1(y)} : t \in F - \{0\},\ x, y \in X - \operatorname{Ker} q_1\right\} < +\infty. \tag{3.4}$$

We shall show that $r = \sup_k p_k/M = \inf_k p_k/M$ which implies that $p_k = p_{k+1}$ for all $k \geq 1$. To this end we observe that

$$\begin{aligned}\mu_{\inf} &= \sup\left\{\frac{q_1(txy)}{|t|^r q_1(x)q_1(y)} : t \in F - \{0\},\ x,y \in X - \operatorname{Ker} q_1\right\}\\ &\geq \sup\left\{\frac{q_1(txy)}{|t|^r q_1(x)q_1(y)} : t \in F - \{0\},\ x,y = (1,1,1,\dots)\right\}\\ &\geq \sup\left\{\frac{\sup_k |t|^{p_k/M}}{|t|^r} : t \in F,\ |t| \geq 1\right\} = \sup\left\{|t|^{\sup_k p_k/M} : t \in F,\ |t| \geq 1\right\}\end{aligned} \tag{3.5}$$

so that

$$\mu_{\inf} \geq \sup\left\{\frac{|t|^{\sup_k p_k/M}}{|t|^r} : t \in F,\ |t| \geq 1\right\}. \tag{3.6}$$

If $r < \sup_k p_k/M$, then $\mu_{\inf} = +\infty$ which is a contradiction. Therefore, $r \geq \sup_k p_k/M$. Similarly, we can show that $r \leq \inf_k p_k/M$ from which it follows that $r = \sup_k p_k/M = \inf_k p_k/M$ and the proof is complete.

(a)⇒(c) The same proof as (a)⇒(b).

(c)⇒(a) The same proof as (b)⇒(a).

(d)⇒(b) This is obvious.

(b)⇒(d) Assume that q_1 has M_r-factors. Then, by (a), $p_0 = p_k = p_{k+1}$ for all $k \geq 0$ where p_0 is a positive real number. Moreover, we have

$$q_1(txy) = \sup_k \left|t \cdot (x_k)(y_k)\right|^{p_0/M} = |t|^{p_0/M} \sup_k |x_k y_k|^{p_0/M} = |t|^{p_0/M} q_1(xy) \tag{3.7}$$

for all $x = (x_k)$, $y = (y_k) \in l_\infty(p)$ and all $t \in F$. Putting $y = (1,1,1\dots)$ we see that

$$q_1(tx) = |t|^{p_0/M} q_1(x) \tag{3.8}$$

and the proof is complete. □

Proof of Theorem 3.2. The proof is almost the same as in Theorem 3.1 and will be omitted. □

Remark 3.3. If the algebra X has an identity element x_0 for multiplication and $q \neq 0$ is a near-quasinorm on X which has an M_r-factor on X, then we obtain $q(x_0) > 0$, $\mu_{\inf} \geq 1/q(x_0)$ and

$$\frac{1}{q(x_0)\mu_{\inf}} |t|^r q(xy) \leq q(txy) \leq \mu_{\inf} |t|^r q(x) q(y) \tag{3.9}$$

for all $x, y \in X$ and all $t \in F$.

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Piyapong Niamsup: Department of Mathematics, Faculty of Science, Chiangmai University, Chiangmai 50200, Thailand
E-mail address: scipnmsp@chiangmai.ac.th

Yongwimon Lenbury: Department of Mathematics, Faculty of Science, Mahidol University, Bangkok 10400, Thailand
E-mail address: scylb@mahidol.ac.th

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Assoc. Prof. Wayne Michael Lawton

Department of Mathematics

National University of Singapore

Date : January 9, 2003

Time : 13.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 302** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Elastic Modeling of Brain Tissue for Drug Infusion

by

Assoc. Prof. Wayne Michael Lawton

Department of Mathematics

National University of Singapore

Date : January 10, 2003

Time : 13.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 304** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Fractal Analysis: A Morphometric Method for Life Science

by

Dr. Wannapong Triampo

Department of Physics

Faculty of Science, Mahidol University

Date : February 25, 2003

Time : 13.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 202** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Research in Algebraic Combinatorics

by

Dr. Matteo Mainetti

Sirindhorn International Institute of Technology

Thammasat University

Date : June 3, 2003

Time : 14.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 202** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Surgical Modeling with Elasticity and Fluid Flow

by

Assoc. Prof. Dr. Wayne Michael Lawton

Department of Mathematics

National University of Singapore

Date : July 11, 2003

Time : 13.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 302** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Weighted Function Spaces and Harmonic Majorants

by

Prof. Luis Manuel Tovar

Departamento de Mathematicas

Instituto Politecnico Nacional, Mexico

Date : July 25, 2003

Time : 13.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 305** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Interesting Problems in Soap Bubble Geometry and Discrete Geometry

by

Dr. Wacharin Wichiramala

Departament of Mathematics

University of Illinois at Urbana-Champaign, U.S.A.

Date : August 1, 2003

Time : 13.30 - 14.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 305** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

A New Model for Laser-induced Thermal Damage in the Retina

by

Prof. George Rowlands

Department of Physics

University of Warwick, UK

Date : August 13, 2003

Time : 10.00 a.m.

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 304** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Research in Delay Differential Equations

by

Dr. Dang Vu Giang

Institute of Mathematics, Vietnam

Date : August 19, 2003

: August 27, 2003

Time : 10.00 - 12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 302** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Generalized Lagrange Multiplier Conditions for DC-programs and Nonconvex Programs with DSL Upper Approximations

By

Assoc. Prof. Dr. Nguyen Dinh

Department of Mathematics-Informatics

Pedagogical Institute of Ho Chi Minh City, Vietnam

Date : August 25, 2003

Time : 13.00 - 15.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 202** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All intere..ed parties are cordially invi. d to join our

Special Seminar

on

Sequential Lagrange Multiplier Conditions Characterizing Optimality for Cone-Convex Programs

By

Assoc. Prof. Dr. Nguyen Dinh

Department of Mathematics-Informatics

Pedagogical Institute of Ho Chi Minh City, Vietnam

Date : August 26, 2003

Time : 13.00 - 15.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 202** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Research in Delay Differential Equations

by

Dr. Dang Vu Giang

Institute of Mathematics, Vietnam

Date : August 19, 2003

: August 27, 2003

Time : 10.00 - 12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 302** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Statistical Aspects of Social Network

By

Prof. Dr. Bikas K. Sinha

Indian Statistical Institute

Kolkata, India

Date : September 18, 2003

Time : 13.30 – 14.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 304** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Estimation of Variance Components in Linear mixed Models, a Review

By

Prof. Dr. Bimal K. Sinha

Department of Mathematics and Statistics

University of Maryland Baltimore County

Baltimore, USA

Date : September 18, 2003

Time : 14.30 – 15.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 304** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Introduction to Finite Population Samplings

and

Statistical Methods in Assessing Agreement

By

Prof. Dr. Bikas K. Sinha

Indian Statistical Institute

Kolkata, India

Date : September 19, 2003

Time : 10.00-12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 202** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our Special Seminar on

Compact Operators

Date: September 22, 2003
Time: 13.30-15.30
Location: Rm. M301 M. Building

Schatten Class Operators

Date: September 26, 2003
Time: 13.30-15.30
Location: Rm. K136 K. Building

Schatten Class Operators

Date: September 29, 2003
Time: 13.30-15.30
Location: Rm. M301 M. Building

C - Algebras*

Date: October 3, 2003
Time: 13.30-15.30
Location: Rm. M301 M. Building

C - Algebras*

Date: October 6, 2003
Time: 13.30-15.30
Location: Rm. M301 M. Building

Vonn Neumann Algebras

Date: October 10, 2003
Time: 13.30-15.30
Location: Rm. M202 M. Building

By

Prof. Dr. Sing-Cheong Ong
Central Michigan University, U.S.A.

Host : Department of Mathematics, Faculty of Science
Mahidol University
Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our
Series of Seminars
on

Dynamic and Static Optimization

by
Dr. Dang Vu Giang
Institute of Mathematics, Vietnam

Date:	November	5, 12,19, 2003
	December	3, 24, 2003
	January	7, 14, 21, 28, 2004
	February	4, 11, 18, 25, 2004
	Time:	9.00 - 12.00
	Location:	Rm. **K 128** Chalerm Prakiat Building

Date:	November	26, 2003
	December	17, 2003
	Time:	9.00 - 12.00
	Location:	Rm. **M 302** M. Building

Host : Department of Mathematics, Faculty of Science, Mahidol University
Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

What is Voronoi Tessellation ?

by

Mr. Kittisak Tiyapan

University of Manchester Institute of Science and Technology, U.K.

Date : November 28, 2003

Time : 9.00 - 10.00 a.m.

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 301** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Bioinformatics: Some Challenging Statistical Problems

by

Prof. Pranab Sen

Department of Biostatistics,

University of North Carolina at Chapel Hill, U.S.A.

Date : December 19, 2003

Time : 13.30-16.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 304** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Shock Waves and Supersonic Flight

by

Professor Dening Li

Department of Mathematics,

West Virginia University, USA.

Date : December 26, 2003

Time : 10.00 - 12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 304** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Wavelet Applications to the Petrov-Galerkin Method for Hammerstein Equations

by

Professor Hideaki Kaneko

Department of Mathematics,

Oldominion University, U.S.A.

Date : January 5, 2004

Time : 10.30 - 12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 302** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Discontinuous Galerkin Finite Element Method for Parabolic Problems

by

Prof. Hideaki Kaneko

Department of Mathematics,

Oldominion University, U.S.A.

Date : January 6, 2004

Time : 9.00 - 10.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 306** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

On

Convection in Smart Liquids Under Terrestrial or Micro-gravity Situations

By

Prof. Dr. Pradeep G. Sidheshwar
UGC Centre for Advanced Studies in Fluid Mechanics
Department of Mathematics,
Bangalore University
Karnataka, India

Date : 29-30 April 2004

Time : 10.00-12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 302** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our
Special Seminar
on

Robustness of t-statistic and t-test

by

Prof. Bimal K. Sinha
Department of Mathematics and Statistics,
University of Maryland, Baltimore County, U.S.A.

Date : March 25, 2004
Time : 13.30-14.30

Host : Department of Mathematics, Faculty of Science, Mahidol University
Location : Room M 202 M. Building, Faculty of Science, Mahidol University
Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

On The Modeling of Stochastic Systems With Time-Delayed Feedback

By

Dr. Till Daniel Frank

Department of Physics University of Münster
Wilhelm-Klemm-Str. 9, 48149 Münster, Germany

Date : March 24, 2004

Time : 10.00-11.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 304** M. Building, Faculty of Science, Mahidol University
Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our Special Seminar on

Modelling "Complex" Systems
(an Introduction and a Few Comments)

Date: March 23, 2004
Time: 10.30-12.00
Location: Rm. M301 M. Building

Modelling Systems in Ecology

Date: March 25, 2004
Time: 10.30-12.00
Location: Rm. M202 M. Building

Modelling Systems in Epidemiology

Date: March 31, 2004
Time: 10.30-12.00
Location: Rm. M202 M. Building

By

Prof. Marc A. Dubois
Directeur du GDR 489 "ECOFIT"
Directeur du programme "MATECLID"
Service de Physique de l'Etat Condensé
CEA Saclay –Orme des Merisiers
91191 Gif sur Yvette cedex France

Host : Department of Mathematics, Faculty of Science,
Mahidol University
Tel. 02-644-5419 Fax. 02-201-5343

ขอเชิญนักศึกษาและผู้สนใจเข้าฟังการบรรยายพิเศษ

ในหัวข้อเรื่อง

Intra – class Models : Properties and Inference

โดย

Prof. Bimal K. sinha
Department of Mathematics and Statistics,
University of Maryland, Baltimore County, U.S.A.

วันที่ 22 — 24 มีนาคม 2547

เวลา 11.00 — 12.00 น.

ณ ห้อง M 202

All interested parties are cordially invited to join our

Special Seminar

on

Data Mining and Text Classification

by

Nick Cercone

Dalhousie University

Date : March 15, 2004

Time : 13.00-16.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 202** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Intelligent Interface

by

Nick Cercone

Dalhousie University

Date : March 12, 2004

Time : 10.30-11.30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 202** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our
Special Seminar on

Common Cyclic Vectors for Normal Operators

by
Professor Dr. Warren Wogen
University of North Carolina, U.S.A.

Date : February 9, 2004
Time : 10.00-12.00

Host : Department of Mathematics, Faculty of Science Mahidol University
Location : Rm. **M302** M. Building, Faculty of Science, Mahidol University
Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

Please note the change of schedule.*

Special Seminar

on

Some Asymptotic Problems for a Reaction/Diffusion System

by

Professor Thomas I. Seidman

Department of Mathematics and Statistics,

University of Maryland, Baltimore County, U.S.A.

Date : January 23, 2004*

Time : 13.00 - 15.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. ***M 304**** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Hybrid Systems: Discontinuous Dynamics in a Continuous World

by

Professor Thomas I. Seidman

Department of Mathematics and Statistics,

University of Maryland, Baltimore County, U.S.A.

Date : January 20, 2004

Time : 10.00 - 12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 306** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Entitled Introduction to Learning Theory

by

Asst. Prof. Dr. Massimiliano Pontil

Department of Computer Science

University College London, U.K.

Date : January 12, 2004

Time : 11.00 - 12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 303** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Symmetry and its Application to Mechanics

by

Assoc. Prof. Dr. Wayne Michael Lawton

Department of Mathematics,

National University of Singapore

Date : January 9, 2004

Time : 10.00 - 12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 304** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

On

Reliability Estimation from Samples from an Exponential Population

By

Prof. Dr. Bikas K. Sinha

Indian Statistical Institute

Kolkata, Indian

Date : April 30, 2004

Time : 14.00-15.00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 302** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Some Singular Homogenization Problems in Non-linear Elasticity and Pseudo-plasticity

by

Prof. Dr. Christian Licht

Laboratoire de Mécanique et Génie Civil,

Université MONTPELLIER II, France

Date : May 31, 2004

Time : 10:30 - 11:30

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 202** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our
Special Seminar
On

On a Family of Apportionment Indices and Its Limiting Properties

By
Prof. Dr. Bikas K. Sinha
Stat-Math Unit,
Theoretical Statistics and Mathematics Division,
Indian Statistical Institute
Kolkata, India

Date : August 16, 2004
Time : 11.00 – 12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University
Location : Rm. **M 301** M. Building, Faculty of Science, Mahidol University
Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our
Special Seminar on

Delay- and Nonlinear Fokker-Planck Equations

Beyond Conventional Fokker-Planck Equations: *Delay- and Nonlinear Fokker-Planck Equations*	**Date: August 23, 2004** **Time: 13.30-14.30** **Location: Rm. M202 M. Building**
Stochastic Processes Described by Conventional Fokker-Planck Equations	**Date: August 25, 2004** **Time: 13.30-14.30** **Location: Rm. M202 M. Building**
Solutions of Delay Fokker-Planck Equations	**Date: August 27, 2004** **Time: 13.30-14.30** **Location: Rm. M202 M. Building**
Data Analysis in Stochastic Systems with Time-Delayed Feedback	**Date: August 31, 2004** **Time: 13.30-14.30** **Location: Rm. M202 M. Building**
Solutions of Nonlinear Fokker-Planck Equations	**Date: September 2, 2004** **Time: 13.30-14.30** **Location: Rm. M202 M. Building**

By
Dr. Till Daniel Frank
Institute for Theoretical Physics, University of Muenster,
Muenster, Germany

Host: Department of Mathematics, Faculty of Science,
Mahidol University
Tel: 02-644-5419 Fax: 02-201-5343

All interested parties are cordially invited to join our
Special Seminar on

Three formulations of the problem of finding equilibrium configurations
Date: 24 September 2004
Time: 13.30 - 16.30
Location: Rm. **K 130** Chalerm Prakiat Building

Solving the problem by using Lax-Milgram Lemma
Date: 25 September 2004
Time: 13.30 - 16.30
Location: Rm. **K 130** Chalerm Prakiat Building

Solving the problem through Optimization Theory- Equivalency
Date: 1 October 2004
Time: 13.30 - 16.30
Location: Rm. **K 130** Chalerm Prakiat Building

The direct method of Calculus of Variation
Date: 2 October 2004
Time: 13.30 - 16.30
Location: Rm. **K 130** Chalerm Prakiat Building

Some elements of Convex Analysis
Date: 8 October 2004
Time: 13.30 - 16.30
Location: Rm. **K 130** Chalerm Prakiat Building

Some elements of Convex Analysis (continued)
Date: 9 October 2004
Time: 13.30 - 16.30
Location: Rm. **K 130** Chalerm Prakiat Building

by
Professor Christian Licht
University of Montpellier II, France

Host : Department of Mathematics, Faculty of Science,
Mahidol University, Rama 6 Rd., Bangkok 10400
Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our
Special Seminar
On

Three Applications of Common N-Gram Method

By
Prof. Nick Cercone, Dean
Faculty of Computer Science
Dalhousie University, Canada

Date : September 28, 2004
Time : 13.00 – 16.00

Host : Department of Mathematics, Faculty of Science, Mahidol University
Location : Rm. **B 201** B. Building, Faculty of Science, Mahidol University
Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our
Special Seminar on

"Partial Actions of Groups on Algebras"

Topic	Date – Time – Location
• Introduction • Partial actions	Date : October **4**, 2004 Time : 10:00 – 12:00 Location : Rm. M-305 Building
• Enveloping actions	Date : October **5**, 2004 Time : 10:00 – 12:00 Location : Rm. M-305 Building
• Partial skew group rings • The associativity question	Date : October **6**, 2004 Time : 10:00 – 12:00 Location : Rm M-305 Building
• Partial action on semiprime algebras	Date : October **7**, 2004 Time : 10:00 – 12:00 Location : Rm. M-305 Building
• Morita equivalence	Date : October **8**, 2004 Time : 10:00 – 12:00 Location : Rm. M-305 Building
• Partial skew polynomial rings	Date : October **11**, 2004 Time : 10:00 – 12:00 Location : Rm. M-305 Building
• Partial Galois theory of commutative rings • Some questions to be considered	Date : October **12**, 2004 Time : 10:00 – 12:00 Location : Rm. M-305 Building
• Discuss and Exchange ideas	Date : October **13 - 14**, 2004 Time : 10:00 – 14:00 Location : Rm - M-305 Building

By

Professor Dr. Miguel Ferrero

Department of Mathematics, Federal University of Rio Grande do Sul,
Porto Alegre, Brazil

Host : **Department of Mathematics, Faculty of Science, Mahidol University**
Tel : 02-644-5419 Fax : 02-201-5343

All interested parties are cordially invited to join our
Special Seminar
On

Introduction to dyadic Models for Social Network Analysis

By

Prof. Dr. Bikas K. Sinha
Stat-Math Unit,
Theoretical Statistics and Mathematics Division,
Indian Statistical Institute
Kolkata, India

Date : October 18, 2004
Time : 11.00 – 12.00

Host : Department of Mathematics, Faculty of Science, Mahidol University
Location : Rm. **B 201** B. Building, Faculty of Science, Mahidol University
Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our
Special Seminars on

Exchange Properties for Modules and Rings

by

Professor Dr. John Clark
Department of Mathematics, Otago University, New Zealand

Date:	November 22-23, 2004
Time:	10.00 - 12.00
Location:	Rm. **M 302** M Building
Date:	November 24, 2004
Time:	10.00 - 12.00
Location:	Rm. **M 305** M. Building
Date:	November 25, 2004
Time:	10.00 - 12.00
Location:	Rm. **K 136** Chalerm Prakiat Building
Date:	November 26, 2004
Time:	10.00 - 12.00
Location:	Rm. **M 307** M. Building

Host : Department of Mathematics, Faculty of Science, Mahidol University
Rama 6 Rd., Bangkok 10400 Tel. 02-644-5419 Fax. 02-201-5343

All interested parties are cordially invited to join our

Special Seminar

on

Confidence Regions for Random-Effects Calibration Curves with Heteroscedastic Errors

by

Assoc. Prof. Dr. Dulal K. Bhaumik

Department of Psychiatry and Biostatistics

University of Illinois at Chicago, USA.

Date : December 2, 2004

Time : 11:00 - 12:00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 307** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Lecture#1: Methods for Extracting Critical Parameters in Nerve Fiber Models

Lecture#2: Stationary States and Traveling Waves of Excitation in Neural Field Theory

by

Professor Jonathan Bell

Chair, Department of Mathematics and Statistics

University of Maryland, Baltimore County, USA.

Date : January 7, 2005

Time : 10:00 - 12:00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 302** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Non-ejective and Non-extremal Fixed Point Theory

by

Dr. Dang Vu Giang

Hanoi Institute of Mathematics, Vietnam

Date : February 17, 2005

Time : 14:00 - 16:00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 307** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Spectrum of Laplacian in Paley-wiener Spaces

by

Dr. Dang Vu Giang

Hanoi Institute of Mathematics, Vietnam

Date : February 18, 2005

Time : 14:00 - 16:00

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 303** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

On

ML Estimation for Pareto Distribution : Role of Sequential Designs

By

Prof. Dr. Bikas K. Sinha

Stat - Math Unit,

Theoretical Statistics and Mathematics Division,

Indian Statistical Institute. Kolkata, India

Date: February 28, 2005

Time : 13.30 – 14.30 PM.

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M. 202** M. Building , Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Sequential Hypothesis Testing in the Distribution of Lifetime of the Oil Seals

by

Dr. Chana Preecha

Ph.D. in Applied Statistics,

University of Northern Colorado, USA.

Date : February 28, 2005

Time : 15:00 p.m.

Host : Department of Mathematics, Faculty of Science, Mahidol University

Location : Rm. **M 202** M. Building, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel. 0 2644 5419 Fax. 0 2201 5343

All interested parties are cordially invited to join our

Special Seminar

on

Limit theorems in Statisties with Applications.

by

Prof. Bimal K. Sinha

Department of Mathematics and Statistics,

University of Maryland, Baltimore County, U.S.A

Date: March 22 - 25, 2005

Time: 10.00 - 12.00

Host: Department of Mathematics, Faculty of Scuence, Mahidol University

Location: Room M 202 M.Buiding, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel 02-644-5419 Fax. 02-2015343

All interested parties are cordially invited to join our

Special Seminar

on

Some new results on estimation of a common mean of two normals.

by

Prof. Bimal K. Sinha

Department of Mathematics and Statistics,

University of Maryland, Baltimore County, U.S.A

Date: March 25, 2005

Time: 13.30 - 14.30

Host: Department of Mathematics, Faculty of Scuence, Mahidol University

Location: Room M 202 M.Buiding, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel 02-644-5419 Fax. 02-2015343

All interested parties are cordially invited to join our

Special Seminar

on

New Approach and Results: From Linear to Nonlinear Systems

by

Prof. Dr. Vu Ngoc Phat

Institute of Mathematics

Hanoi, Vietnam

Date: April 22 , 2005

Time: 10.00 - 11.00 a.m.

Host: Department of Mathematics, Faculty of Science, Mahidol University

Location: Room M 202 M.Buiding, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel 02-644-5419 Fax. 02-2015343

All interested parties are cordially invited to join our

Special Seminar

on

Applications in Mathematical Control Problems

by

Prof. Dr. Vu Ngoc Phat

Institute of Mathematics

Hanoi, Vietnam

Date: April 29, 2005

Time: 10.00 - 11.00 a.m.

Host: Department of Mathematics, Faculty of Science, Mahidol University

Location: Room M 202 M.Buiding, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel 02-644-5419 Fax. 02-2015343

ติดประกาศ

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All interested parties are cordially invited to join our

Special Seminar

on

Hankel Operator on Bergman Space

by

Dr. Zen Harper

Department of Pure Mathematics

Leeds University, U.K.

Date: May 3 ,2005

Time: 10.00 - 11.00 am.

Host: Department of Mathematics, Faculty of Scuence, Mahidol University

Location: Room M 202 M.Buiding, Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel 02-644-5419 Fax. 02-2015343

All interes d parties are cordially invited join our

Special Seminar

on

Theory and Applications of Shadowing in Dynamical Systems

by

Prof. Kenneth Palmer

Department of Mathematics

National Taiwan University

Date: July 18, 2005

Time: 14.00 - 15.00 pm.

Host: Department of Mathematics, Faculty of Science, Mahidol University

Location: Room M.302, M.Building Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel 02-644-5419 Fax. 02-2015343

All interested parties are cordially invited to join our

Special Seminar

on

Semantic Representation and Machine Translation

by

Prof. Nick Cercone

Dalhousie University, Canada

Date: July 19, 2005

Time: 10.00 - 12.00 a.m.

Host: Department of Mathematics, Faculty of Science, Mahidol University

Location: Room M.306 M.Building Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel 02-644-5419 Fax. 02-2015343

All interested parties are cordially invited to join our

Special Seminar

on

ONTOLOGY

by

Prof. Nick Cercone

Dalhousie University, Canada

Date: July 20, 2005

Time: 13.30 - 15.30

Host: Department of Mathematics, Faculty of Science, Mahidol University

Location: Room M.306 M.Building Faculty of Science, Mahidol University

Rama 6 Rd., Bangkok 10400 Tel 02-644-5419 Fax. 02-2015344