

**Ministry of Education  
Department of Higher Education  
Yangon University of Distance Education**

**Yangon University of  
Distance Education  
Research Journal**

Vol. 10, No. 1

December, 2019

**Ministry of Education  
Department of Higher Education  
Yangon University of Distance Education**

**Yangon University of  
Distance Education  
Research Journal**

Vol. 10, No. 1

December, 2019

Contents	Page
<b>Patriotic Pride from U Latt's Novel, "Sabae Bin"</b>	1-4
<i>Kyu Kyu Thin</i>	
<b>Creation of characters in Kantkaw a novel of Linkar Yi Kyaw</b>	5-9
<i>Khin San Wint</i>	
<b>Author Khin Khin Htoo's Creative Skill of Writing a Story " Ku Kuu"</b>	10-15
<i>Kyin Thar Myint</i>	
<b>A Stylistic Analysis of the poem "the road not taken" by Robert Frost</b>	16-22
<i>Nyo Me Kyaw Swa</i>	
<b>The Effectiveness of Critical Thinking on Students in Classroom</b>	22-26
<i>Amy Thet</i>	
<b>Making Education Accessible: an investigation of an integrated English teaching-learning system in first year online class at Yangon University of Distance Education</b>	26-33
<i>Ei Shwe Cin Pyone</i>	
<b>A Geographical Study on Spatial Distribution Pattern of Health Care Centres in Sanchaung Township</b>	33-39
<i>Myo Myo Khine, Win Pa Pa Myo, Min Oo, Kaythi Soe</i>	
<b>A Study of Crop-Climate Relationship in Hlegu Township</b>	39-45
<i>Win Pa Pa Myo, Myo Myo Khine</i>	
<b>How to Organize Data for Presentation</b>	46-50
<i>Yee Yee Myint, Myint Myint Win</i>	
<b>A Geographical Study on Open University in New Zealand</b>	50-54
<i>Myint Myint Win, Yee Yee Myint</i>	
<b>Royal Administrative Practices in Konbaung Period (1752-1885)</b>	54-60
<i>Yin Yin Nwe</i>	
<b>Pyidawtha Programme (1952-1960)</b>	60-69
<i>Zaw Naing Myint</i>	
<b>The Role of Saya San in Myanmar Politics (1930-1931)</b>	70-76
<i>Hlaing Hlaing Nyunt</i>	
<b>A Study of the Floral Arabesque Patterns in Myanmar Traditional Paintings</b>	76-81
<i>Hla Hla Nwe</i>	
<b>A Study on Job Stress of Office Staff from Yangon University of Distance Education</b>	82-86
<i>Khin Ya Mone, Ma Aye, Theint Thiri Zan</i>	
<b>A study on the job satisfaction of the teaching staff in Yangon University of Distance Education</b>	86-91
<i>Theint Thiri Zan, Thiri Hlaing, Ma Aye</i>	
<b>A study on the work motivation of the teaching staff in Yangon University of Distance Education</b>	91-96
<i>Ma Aye, Khin Ya Mone, Theint Thiri Zan</i>	
<b>A study of Aristotle's Golden mean</b>	97-101
<i>Nwe Nwe Oo</i>	
<b>A Study of Legal Thought of John Austin</b>	102-109
<i>Aye Aye Cho</i>	
<b>A study of the concept of "good will" in Kantian philosophy from the Myanmar philosophical thought</b>	109-115
<i>Moe Aye Theint</i>	
<b>The Term "Pāragū" in the Buddhist Scriptures</b>	115-121
<i>Theingi Cho</i>	
<b>Arāḍa's Teaching from the Buddhacarita</b>	122-126
<i>Pa Pa Aung</i>	
<b>The Merit of Donating Four Material Requisites</b>	126-131
<i>Marlar Oo</i>	
<b>The Benefits of Workers under the Workmen's Compensation Act in Myanmar</b>	131-135
<i>Khin Mar Thein</i>	

Contents	Page
<b>Study on the Humanitarian Intervention under International Law</b> <i>Nu Nu Win</i>	136-141
<b>A Study on the Quality of Fried Edible Oil (Palm Oil)</b> <i>Thazin Lwin, Myo Pa Pa Oo, Nyi Nyi</i>	142-148
<b>New Ceramer Coating Based on Titanium-resorcinol Copolymer with Blown Seed Oils</b> <i>Yu Yu Myo, Nwe Ni Win, Thazin Win</i>	149-156
<b>A Study on Antioxidant Activity of Edible Green Leaves of Brassica Juncea Linn. (Mom-Hnyin-Sein)</b> <i>Ohmar Ko, Thuzar Win, Hnin Yee Lwin</i>	156-161
<b>Microcontroller controlled four-digit timer</b> <i>Lei Lei Aung, Myo Nandar Mon, Khin Phyu Win, Moh Moh</i>	161-166
<b>Study On Current-Voltage Characteristics of Znte Electroplated Film Under Illumination</b> <i>Myo Nandar Mon, Thi Thi Win, Lei Lei Aung, Moh Moh</i>	166-172
<b>Effect of Heat Treatment on Optical Properties of Cd-doped ZnO Thin Film</b> <i>Su Thaw Tar Wint, Myo Myint Aung, Moh Moh</i>	173-175
<b>Radon concentration in soil samples from different layers of the underground of Bago University campus</b> <i>Thi Thi Win, Myo Nandar Mon, Aye Aye Khine, Moh Moh</i>	176-180
<b>A Study on Weakly Preopen and Weakly Preclosed Functions</b> <i>Kaythi Khine, Nang Moe Moe Sam, Su Mya Sandy</i>	181-187
<b>Functions and Their Graphical Representation</b> <i>Ohmar Myint, Moe Moe San, Zar Chi Saint Saint Aung</i>	187-193
<b>Trilinear and Quadrilinear Forms</b> <i>Wai Wai Tun, Aye Aye Maw</i>	193-198
<b>Prevalence and bionomics of <i>Aedes aegypti</i> (Linnaeus, 1762) larvae in high risk areas of Pazundaung Township, Yangon Region</b> <i>Tin Mar Yi Htun</i>	198-204
<b>Comparative study of helminthes parasitic eggs and larvae in goat from Magway Township</b> <i>Nilar Win, Myat Thandar Swe, Thinzar Wint</i>	205-213
<b>Endoparasites of anurans from north Dagon and Kamayut Townships</b> <i>Pa Pa Han, Thuzar Moe, Phyo Ma Ma Lin, Aye Aye Maw</i>	213-218
<b>Investigation of some invertebrates in Taungthaman Lake, Amarapura Township, Mandalay Division</b> <i>Khin Than Htwe, Kathy Myint, Thin Thin Swe, Aye Kyi</i>	219-225
<b>Antimicrobial activity of <i>Dolichandrone spathacea</i> (L.f.) k. Schum. Flowers</b> <i>Moet Moet Khine, Tin Tin Nwe, Win Win Shwe, Mya Mya Win</i>	226-231
<b>Five Selected Wild Medicinal Plants and Theirs' Uses</b> <i>Mya Mya Win, Moet Moet Khine, Win Win Shwe</i>	232-237
<b>The Comparison of the Yield from Non-Grafted and Grafted of Five Plants of Family Solanaceae</b> <i>Win Win Shwe, Moet Moet Khine, Mya Mya win</i>	238-244
<b>Silk Fabrics Factories in Amarapura</b> <i>Win Thida, Ni Ni Win, Yu Lae Khaing</i>	245-251
<b>A study on production of rubber in Myanmar (1996 - 97 to 2017- 2018)</b> <i>Tin Tin Mya, Ni Ni Win, Thinzar Aung</i>	251-257
<b>A Study on Factors Affecting the Exclusive Breastfeeding of Mothers in PYA-PON District</b> <i>Khin Mar Kyi, May Zin Tun</i>	258-265
<b>A Study on the Health Status and Physical Fitness of Elderly People at Home for the Aged (Hninzigone), Yangon</b> <i>Hein Latt, Pyae Phyo Kyaw</i>	266-273
<b>A Study on Mortality and Fertility levels of Myanmar and its Neighbouring Countries</b> <i>Ni Ni Win, Thinn Thinn Aung, Thinzar Aung</i>	273-280

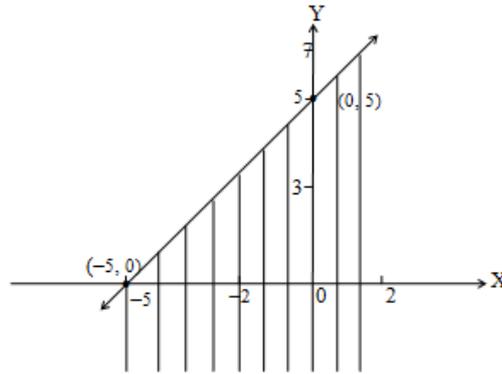


Figure (ix)

**Acknowledgements**

We wish to express our thanks to Dr. Tin Maung Hla, Rector of Yangon University of Distance Education, for his kind permission to carry out this research. Our special thanks also go to Dr. Khin Thant Sin, Pro-Rector of Yangon University of Distance Education.

We are deeply indebted to my respectable Professor Dr. Moe Moe San, Head of Department of Mathematics and Professor Dr. Nang Moe Moe Sam, Department of Mathematics, Yangon University of Distance Education, for their kind permission and encouragements throughout this research paper.

**References**

E. P. Vance. *Modern Algebra and Trigonometry*, Addison-Wesley Publishing Company, Inc. 1962.  
 Howard Anton. *Calculus with Analytic Geometry*, (5<sup>th</sup>ed.). John Wiley & Sons, Inc. 1995.

\*\*\*\*\*

**Trilinear and Quadrilinear Forms**

Wai Wai Tun<sup>1</sup>, Aye Aye Maw<sup>2</sup>

**Abstract**

Most of the partial differential equations that arise in Continuum Mechanics and Physics are nonlinear. Because of their nonlinearity, the mathematical study of these equations is difficult and require the full power of modern functional analysis. This paper deals with the trilinear and quadrilinear forms to construct the variational formulation of some nonlinear partial differential equations of higher order.

**Key words:** trilinear, quadrilinear, variational formulation

**1. Introduction**

Let  $\Omega$  be a Lipschitz open bounded subset in  $\mathbb{R}^n$ . We shall use the notation of the spaces  $V = \{u \in D(\Omega), \text{div } u = 0\}$ ,  $V$  = the closure of  $V$  in  $H_0^1(\Omega)$ ,  $H$  = the closure of  $V$  in  $L^2(\Omega)$ ,  $W = D(\Omega)$ ,  $W$  = the closure of  $W$  in  $H_0^1(\Omega)$ ,  $G$  = the closure of  $W$  in  $L^2(\Omega)$ . Let  $V', W', H'$  and  $G'$  denote the dual spaces of  $V, W, H$  and  $G$ . Then we have the inclusions  $V \subseteq H \equiv H' \subseteq V'$  and  $W \subseteq G \equiv G' \subseteq W'$ .

**1.1 Lemma** [Temam, R. 1977] *Let  $V, H, V'$  be three Hilbert spaces with  $V \subseteq H \equiv H' \subseteq V'$ . Let  $u \in L^2(0, T; V)$  and  $u' \in L^2(0, T; V')$ . Then  $u : [0, T] \rightarrow H$  is continuous a.e and*

$$\frac{d}{dt} |u|^2 = 2 \langle u', u \rangle$$

*holds in scalar distribution sense on  $(0, T)$ .*

<sup>1</sup>Associate Professor, Dr, Department of Mathematics, Yangon University of Distance Education

<sup>2</sup>Associate Professor, Dr, Department of Mathematics, Yangon University of Distance Education

**1.2 Lemma** [Temam, R. 1977] If  $u_\mu$  converges to  $u$  and  $v_\mu$  converges to  $v$  in  $L^2(0, T; V)$  weakly and  $L^2(0, T; H)$  strongly, then for any vector function  $w$  with components in  $C^1(\bar{Q})$ ,

$$\int_0^T b(u_\mu(t), v_\mu(t), w(t)) dt \rightarrow \int_0^T b(u(t), v(t), w(t)) dt.$$

**1.3 Definition** [Temam, R. 1983] Let  $\Omega$  be an open set in  $\mathbb{R}^n$  and let  $p$  be a distribution on  $\Omega$ . Then, for any  $v \in V$ ,

$$\langle \text{grad } p, v \rangle = \sum_{i=1}^n \langle D_i p, v_i \rangle = - \sum_{i=1}^n \langle p, D_i v_i \rangle = \langle p, \text{div } v \rangle = 0.$$

**1.4 Definition** [Temam, R. 1983] For fixed  $u$  in  $V$ , the mapping  $V \rightarrow \mathbb{R}, v \mapsto ((u, v))$  is linear and continuous on  $V$ . Then there exists an element of  $V'$ , denote  $Au$  such that  $\langle Au, v \rangle = ((u, v)), \forall v \in V$ . Then  $u \rightarrow Au$  is linear and continuous and also an isomorphism from  $V$  to  $V'$ .

**1.5 Definition** [Temam, R. 1983] Let  $X$  be a Hilbert space. If  $v$  is a function from  $\mathbb{R}$  into  $X$  then we denote the Fourier transform of  $v$  by  $\hat{v}$  as

$$\hat{v}(\tau) = \int_{-\infty}^{\infty} e^{-2i\pi\tau t} v(t) dt \text{ and}$$

the derivative in  $t$  of order  $r$  of  $v$  is the inverse Fourier transform of  $(2i\pi\tau)^r \hat{v}$  or

$$D_t^r v(\tau) = (2i\pi\tau)^r \hat{v}(\tau).$$

The definition is consistent with the usual definition for an integer  $r$ .

**2. Boundness of Trilinear and Quadrilinear Forms**

**2.1 Lemma** [Temam, R. 1977] If the dimension is  $n = 3$ , for any open set  $\Omega = 3$ , then

$$\|v\|_{L^4(\Omega)} \leq 2^{1/2} \|v\|_{L^2(\Omega)}^{1/4} \|\text{grad } v\|_{L^2(\Omega)}^{3/4}, \forall v \in H_0^1(\Omega).$$

**2.2 Lemma** [Temam, R. 1977] Let  $\Omega$  be bounded or unbounded and any dimension of the space  $\mathbb{R}^n$ . Then, the form  $b$ ,

$$b(u, v, w) = \sum_{i,j=1}^n \int_{\Omega} u_i (D_i v_j) w_j dx$$

is defined and trilinear continuous on  $[H_0^1(\Omega)]^3 \cap L^n(\Omega)$ .

**2.3 Lemma** [Temam, R. 1983] for any open set  $\Omega$ ,  $b$  is trilinear continuous on  $(H_0^1(\Omega))^3 \cap L^n(\Omega)$ . If  $\Omega$  is bounded and  $n \leq 4$  then  $b$  is trilinear continuous on  $[H_0^1(\Omega)]^3$ .

**2.4 Lemma** [Temam, R. 1983] Assumed that the dimension of the space is  $n \leq 4$  and  $u, v \in L^2(0, T; V)$ .

Let the function  $B(u, v)$  be defined by

$$\langle u(t), v(t), w \rangle = b(u(t), v(t), w), \forall w \in V, a.e \text{ int } t \in [0, T]$$

then  $B(u, v) \in L^1(0, T; V')$ .

**2.5 Lemma** [Temam, R. 1977] If  $u_\mu$  converges to  $u$  and  $v_\mu$  converges to  $v$  in  $L^2(0, T; V)$  weakly and  $L^2(0, T; H)$  strongly, then for any vector function  $w$  with components in  $C^1(\bar{Q})$ ,

$$\int_0^T b(u_\mu(t), v_\mu(t), w(t)) dt \rightarrow \int_0^T b(u(t), v(t), w(t)) dt.$$

In particular, the trilinear form  $\bar{b}$  defined by

$$\bar{b}(u, \theta, \gamma) = \sum_{i=1}^3 \int_{\Omega} u_i (D_i \theta) \gamma \, dx$$

Is well defined and trilinear continuous on  $[H_0^1(\Omega)]^3 \cap [L^2(\Omega)]^3$ ,  $\Omega$  bounded and  $\Omega \subseteq \mathbb{R}^3$ .  $\bar{b}$  also has the same properties as  $b$  for  $u \in L^2(0, T; V)$  and  $\theta \in L^2(0, T; W)$ .

Using these results, we prove the following theorems:

**2.6 Theorem** *The trilinear forms  $c_1$  and  $c_2$*

$$c_1(\theta, h, \gamma) = \sum_{i=1}^3 \int_{\Omega} \theta (\text{curl } h)_i \gamma \, dx$$

$$c_2(h, \theta, \gamma) = \sum_{i=1}^3 \int_{\Omega} \theta (\text{curl } h)_i (D_i \theta) \gamma \, dx$$

are defined and trilinear continuous on  $[H_0^1(\Omega)]^3 \cap [L^2(\Omega)]^3$ ,  $\Omega$  bounded in  $\mathbb{R}^3$  for

$$|(\text{curl } h)_i| \ll 1 \text{ and } (D_i \theta) \ll 1, i = 1, 2, 3.$$

**Proof:** By general Hölder inequality

$$\left| \int_{\Omega} \theta (\text{curl } h)_i \gamma \, dx \right| \leq |\theta|_{L^4(\Omega)} |(\text{curl } h)_i|_{L^2(\Omega)} |\gamma|_{L^4(\Omega)},$$

$$\sum_{i=1}^3 \left| \int_{\Omega} \theta (\text{curl } h)_i \gamma \, dx \right| \leq \sum_{i=1}^3 |\theta|_{L^4(\Omega)} |(\text{curl } h)_i|_{L^2(\Omega)} |\gamma|_{L^4(\Omega)}. \tag{1}$$

Then  $c_1(\theta, h, \gamma)$  is well-defined and

$$c_1(\theta, h, \gamma) \leq K_0(\Omega) \|\theta\|_{H_0^1(\Omega)} \|h\|_{H_0^1(\Omega)} \|\gamma\|_{H_0^1(\Omega)}.$$

Therefore the form  $c_1$  is trilinear continuous on  $[H_0^1(\Omega)]^3 \cap [L^2(\Omega)]^3$ .

Also, by using Hölder inequality, we obtain

$$\left| \int_{\Omega} (\text{curl } h)(D_i \theta) \gamma \, dx \right|_i \leq \int_{\Omega} |(\text{curl } h)_i (D_i \theta) \gamma| \, dx.$$

Choose  $\left| \int_{\Omega} (\text{curl } h)_i \right| \ll 1, i = 1, 2, 3.$

By Hölder inequality, we obtain

$$\left| \int_{\Omega} (\text{curl } h)(D_i \theta) \gamma \, dx \right| \leq \int_{\Omega} |(D_i \theta) \gamma| \, dx$$

$$\leq \int_{\Omega} |(D_i \theta)|_{L^2(\Omega)}$$

and then

$$\sum_{i=1}^3 \int_{\Omega} |(\text{curl } h)_i (D_i \theta) \gamma| \, dx \leq \sum_{i=1}^3 |D_i \theta|_{L^2(\Omega)} |\gamma|_{L^2(\Omega)},$$

$$|c_2(h, \theta, \gamma)| \leq \varepsilon_1 \|\theta\|_{H_0^1(\Omega)} |\gamma|_{L^2(\Omega)}. \tag{2}$$

Again, we can choose  $|D_i \theta| \ll 1$ , by Hölder inequality,

$$\left| \int_{\Omega} (\text{curl } h)(D_i \theta) \gamma \, dx \right|_i \leq \int_{\Omega} |(\text{curl } h)_i \gamma| \, dx$$

$$\leq \int_{\Omega} |(\text{curl } h)_i \gamma|_{L^2(\Omega)}$$

then we get

$$\sum_{i=1}^3 \int_{\Omega} |(curl h)_i (D_i \theta) \gamma| dx \leq \sum_{i=1}^3 |(curl h)_i|_{L^2(\Omega)} |\gamma|_{L^2(\Omega)},$$

$$|c_2(h, \theta, \gamma)| \leq \varepsilon_2 \|h\|_{H_0^1(\Omega)} |\gamma|_{L^2(\Omega)}. \tag{3}$$

According to (2) and (3), the form  $c_2$  is trilinear continuous on  $[H_0^1(\Omega)]^3 \cap [L^2(\Omega)]^3$ .

By (2) and (3), we have the inequality

$$|c_2(h, \theta, \gamma)| \leq \left[ \varepsilon_1 \|\theta\|_{H_0^1(\Omega)} + \varepsilon_2 \|h\|_{H_0^1(\Omega)^+} \right] |\gamma|_{L^2(\Omega)}. \tag{4}$$

**2.7 Theorem** The form  $c_3$ ,

$$c_3(h, \theta, \alpha, \gamma) = \sum_{i=1}^3 \int_{\Omega} (curl h)_i (D_i \theta) \alpha \gamma dx$$

is defined and quadrilinear continuous on  $[H_0^1(\Omega)]^4 \cap [L^2(\Omega)]^4$ ,  $\Omega$  bounded subset in  $\mathbb{R}^3$  and for  $|(curl h)_i| \ll 1$  and  $|D_i \theta| \ll 1, i = 1, 2, 3$ .

**Proof:** From the form  $c_3$ , we have the inequality

$$\left| \int_{\Omega} (curl h)_i (D_i \theta) \alpha \gamma dx \right| \leq \int_{\Omega} |(curl h)_i (D_i \theta) \alpha \gamma| dx.$$

Choose  $|(curl h)_i| \ll 1, i = 1, 2, 3$  and using general Hölder inequality,

$$\left| \int_{\Omega} (curl h)_i (D_i \theta) \alpha \gamma dx \right| \leq |D_i \theta|_{L^2(\Omega)} \|\alpha\|_{L^4(\Omega)} \|\gamma\|_{L^4(\Omega)}.$$

$$\sum_{i=1}^3 \left| \int_{\Omega} (curl h)_i (D_i \theta) \alpha \gamma dx \right| \leq \sum_{i=1}^3 |D_i \theta|_{L^2(\Omega)} \|\alpha\|_{L^4(\Omega)} \|\gamma\|_{L^4(\Omega)}.$$

So,

$$|c_3(h, \theta, \alpha, \gamma)| \leq \varepsilon_3 \|\theta\|_{H_0^1(\Omega)} \|\alpha\|_{L^4(\Omega)} |\gamma|_{L^4(\Omega)}. \tag{5}$$

Again, choosing  $|D_i \theta| \ll 1$ , we get

$$\sum_{i=1}^3 \left| \int_{\Omega} (curl h)_i (D_i \theta) \alpha \gamma dx \right| \leq \sum_{i=1}^3 |(curl h)_i|_{L^2(\Omega)} \|\alpha\|_{L^4(\Omega)} \|\gamma\|_{L^4(\Omega)}.$$

It leads to the inequality

$$|c_3(h, \theta, \alpha, \gamma)| \leq \varepsilon_4 \|h\|_{H_0^1(\Omega)} \|\alpha\|_{L^4(\Omega)} |\gamma|_{L^4(\Omega)}. \tag{6}$$

By using (5) and (6), we can conclude  $c_3(h, \theta, \alpha, \gamma)$  is well-defined and continuous. Therefore, the form is quadrilinear and continuous.

From (5) and (6), we get inequality

$$|c_3(h, \theta, \alpha, \gamma)| \leq \left( \varepsilon_3 \|\theta\|_{H_0^1(\Omega)} + \varepsilon_4 \|h\|_{H_0^1(\Omega)} \right) \|\alpha\|_{L^4(\Omega)} |\gamma|_{L^4(\Omega)}. \tag{7}$$

### 3. Some Properties of Trilinear and Quadrilinear Forms

#### 3.1 Fundamental Properties of Trilinear Forms $b$ and $\bar{b}$

- (i)  $b(u, v, v) = 0, \forall u \in V, v \in H_0^1(\Omega) \cap L^2(\Omega)$ .
- (ii)  $b(u, v, w) = -b(u, w, v), \forall u \in V, v, w \in H_0^1(\Omega) \cap L^2(\Omega)$ .
- (iii)  $\bar{b}(u, v, v) = 0, \forall u \in V, v \in H_0^1(\Omega) \cap L^2(\Omega)$ .
- (iv)  $\bar{b}(u, v, w) = -\bar{b}(u, w, v), \forall u \in V, v, w \in H_0^1(\Omega) \cap L^2(\Omega)$ .

#### 3.2 Properties of Trilinear Form $c_2$ and Quadrilinear Form $c_3$

- (i)  $c_2(h, \theta, \theta) = 0,$
- (ii)  $c_3(h, \theta, \theta, \theta) = 0, \forall h \in H_0^1(\Omega).$

**3.3 Lemma** Let  $\Omega$  be a bounded subset of  $\mathbb{R}^3$ . If  $h \in L^2(0, T; V), \theta \in L^2(0, T; W), \alpha \in L^2(0, T; W)$  and  $\gamma \in W$  and the functions  $C_1(\theta, h), C_2(h, \theta)$  and  $C_3(h, \theta, \alpha)$  defined by

$$\begin{aligned} \langle C_1(\theta, h), \gamma \rangle &= c_1(\theta(t), h(t), \gamma), \\ \langle C_2(h, \theta), \gamma \rangle &= c_2(h(t), \theta(t), \gamma), \\ \langle C_3(h, \theta, \alpha), \gamma \rangle &= c_3(h(t), \theta(t), \alpha(t), \gamma), \forall \gamma \in W, \end{aligned}$$

Then  $C_1(\theta, h), C_2(h, \theta)$  and  $C_3(h, \theta, \alpha) \in L^1(0, T; W')$ .

**Proof:** Since  $c_1$  and  $c_2$  are trilinear continuous, that is,  $C_1: W \rightarrow W'$  and  $C_2: W \rightarrow W'$  are continuous. Since  $\theta \in L^2(0, T; W)$  and  $h \in L^2(0, T; V)$  and then  $\theta$  and  $h$  are measurable.

For almost all  $t, \theta: [0, T] \rightarrow W'$  and  $h \in [0, T] \rightarrow W$  are measurable.

So,  $C_1(\theta, h): [0, T] \rightarrow W'$  and  $C_2(h, \theta): [0, T] \rightarrow W'$  are measurable and

$$\begin{aligned} \int_0^T \|C_1(\theta, h)\|_{W'} dt &\leq K_0 \int_0^T \|\theta\|_{H_0^1(\Omega)} \|h\|_{H_0^1(\Omega)} dt, \\ \int_0^T \|C_2(h, \theta)\|_{W'} dt &\leq \int_0^T (\varepsilon_1 \|\theta\|_{H_0^1(\Omega)} + \varepsilon_2 \|h\|_{H_0^1(\Omega)}) dt. \end{aligned}$$

Therefore,  $C_1(\theta, h)$  and  $C_2(h, \theta) \in L^1(0, T; W')$ .

Also,  $c_3$  is quadrilinear continuous then  $\|C_3(h, \theta, \alpha)\| \leq (\varepsilon_3 \|\theta\|_{H_0^1(\Omega)} + \varepsilon_4 \|h\|_{H_0^1(\Omega)}) \|\alpha\|_{L^2(\Omega)}$ .

This means that  $C_3: W \rightarrow W'$  is continuous.

By the assumptions,  $h$  is a measurable function from  $[0, T]$  to  $V$ , the scalar functions  $\theta$  and  $\alpha$  are measurable functions from  $[0, T]$  to  $W$ . Hence,  $C_3: [0, T] \rightarrow W'$  is measurable and

$$\int_0^T \|C_3(h(t), \theta(t), \alpha(t))\|_{W'} dt \leq K_2 \int_0^T (\varepsilon_3 \|\theta\|_{H_0^1(\Omega)} + \varepsilon_4 \|h\|_{H_0^1(\Omega)}) \|\alpha\|_{L^2(\Omega)} dt.$$

Therefore,  $C_3(h, \theta, \alpha) \in L^1(0, T; W')$ .

**3.4 Theorem** If  $u_\mu$  converges to  $u$  and  $h_\mu$  converges to  $h$  in  $L^2(0, T; V)$  weakly and in  $L^2(0, T; H)$  strongly and  $\theta_\mu$  converges to  $\theta$  in  $L^2(0, T; W)$  weakly and  $L^2(0, T; G)$  strongly, then for any scalar function  $\gamma$  in  $C^1(\bar{Q})$ ,

- (i)  $\int_0^T c_1(\theta_\mu, h_\mu, \gamma) dt \rightarrow \int_0^T c_1(\theta, h, \gamma) dt$  and
- (ii)  $\int_0^T c_2(h_\mu, \theta_\mu, \gamma) dt \rightarrow \int_0^T c_2(h, \theta, \gamma) dt.$

Proof is obvious by the properties of the trilinear forms.

### Acknowledgements

We wish to express our thanks to Dr. Tin Maung Hla, Rector of Yangon University of Distance Education, for his kind permission to carry this research. Our special thanks are due to Dr. Khin Thant Sin, Pro-Rector of Yangon University of Distance Education.

We are deeply indebted to our respectable Professor Dr. Moe Moe San, Head of Department of Mathematics and Professor Dr. Nang Moe Moe Sam, Department of Mathematics, Yangon University of Distance Education, for their kind permission and encouragements throughout this research work.

### References

- Friedman, A: *Foundations of Modern Analysis*, Dover Publications Inc, New York, 1982.  
 Straughan, B : *Stability Problems in Electrohydrodynamics, Ferrohydrodynamics and Thermoelectric agnetohydrodynamics*, Mathematical Topics in Fluid Dynamics, Edited by Rodrigues, J.F. and Sequeira, A., Pitman Res. Notes Math. Ser. 274, (163-192),1992.  
 Temam, R:*Navier-Stokes Equations, Theory and Numerical Analysis*, North- Holland Publishing Company, Amsterdam, New York, Oxford, 1977.  
 Temam, R:*Navier-Stokes Equations, and nonlinear Functional Analysis*, Society for Industrial and Applied Mathematics, 1983.

\*\*\*\*\*

## Prevalence and bionomics of *Aedes aegypti* (Linnaeus, 1762) larvae in high risk areas of Pazundaung Township, Yangon Region

Tin Mar Yi Htun\*

### Abstract

Dengue viruses are actively transmitted by *Aedes aegypti* in many countries in the tropical zone throughout the world including Myanmar. The successful control of this species depends on knowledge of the biology and ecology of this mosquito vector including the development and survival in different container types. A total of 31 selected places (altogether 28 compounds of 9 Primary, 4 Middle and 4 High schools, 1 local health centers and 10 private day care centers/nurseries) were surveyed seasonally to determine the prevalence and bionomics of *Aedes aegypti* larvae in different container categories and types at selected areas of Pazundaung Township in relation to children aggregated areas from December, 2017 to September, 2018. Out of 31 selected places investigated (28 compounds), 16.13% in first survey, 61.29% in second survey and 38.71% in third survey of the places were found to be larva positive.

Keywords: *Aedes aegypti*, different container categories and types, positive premises

### Introduction

*Aedes aegypti* is one of the world's most widely distributed mosquitoes and is of considerable medical importance as a vector of dengue and yellow fever (Service, 1992). The species is considered as the major vector of dengue, dengue haemorrhagic fever and dengue shock syndrome (DF/DHF/DSS) in many subtropical and tropical countries throughout the world. Prevention of DHF outbreaks in endemic areas is based on long-term anti-mosquito control measures particularly household and environmental sanitation with emphasis on larval source reduction. Only vector control promises permanency and a cost effective solution (Halstead, 1988).

In Myanmar, a severe outbreak of DHF occurred for the first time in Yangon in 1970. The urban areas within the Yangon City limits were more affected than the suburban townships of Yangon Division. This epidemic had an average morbidity of 51.97 per 100,000 population and affected mostly school going age groups.

Generally more DHF cases were abundant during rainy season especially in July and August. There was the highest number of cases in July (Ohn Kyi, 1985). However, the intervals between dengue outbreaks became shorter in the last two decades. High dengue cases in the rainy season correspond to the seasonal high densities of *Aedes aegypti* mosquitoes that are the vectors of DHF. Since Dengue/DHF is a mosquito-borne viral disease, only

---

\* Professor/Head, Dr, Department of Zoology, Yangon University of Distance Education