

ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံတော်အစိုးရ

၃

ပညာရေးဝန်ကြီးဌာန
အဆင့်မြင့်ပညာဦးစီးဌာန
ကျိုင်းတုံတက္ကသိုလ်



ဝန်ကြီးပြုမှတ်တမ်းလွှာ

၂၀၁၈ ခုနှစ်၊ ကျိုင်းတုံတက္ကသိုလ် (၁၁)နှစ်မြောက် နှစ်ပတ်လည်နေ့အထိမ်းအမှတ်
သုတေသနစာတမ်းဖတ်ပွဲတွင် ဖတ်ကြားခဲ့သည့် စာတမ်းရှင်အမည် ဒေါက်တာသက်စွန်းဝင်း

ရာထူး လက်က ၊ ဌာန သင်္ချာ အား

ဤဝန်ကြီးပြုမှတ်တမ်းလွှာကို ချီးမြှင့်လိုက်သည်။

ဒေါက်တာ စမ်းစမ်းမာ
ပါမောက္ခချုပ်
ကျိုင်းတုံတက္ကသိုလ်

ရက်စွဲ၊ ၂၀၁၈ ခုနှစ်၊ ဇန်နဝါရီလ (၂၂)ရက်

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Content

	Page
အောင်သင်း၏ “အနီးအဝေး” ရုသစာတမ်းမှ အတွေးနှင့် အရေး ဒေါ်မာလာမိုး	1
မြန်မာဘာသာစကားတွင် အနက်ပိုလွန်ခြင်း ဒေါက်တာသန်းသန်းအေး	8
လွမ်းချင်းကဗျာများမှ မြန်မာ့ကျေးလက်ဓလေ့များ ဒေါ်ခင်နီလာလွင်	14
တောင်ရိုးတိုင်းရင်းသားတို့၏ အနုရိုးကဗျာများတွင် ထင်ဟပ်လျက်ရှိသော ဓလေ့စရိုက်များ လေ့လာချက် ဒေါ်စုမွန်ထွေး	20
အရှေ့က နေ့ဝန်းထွက်သည့်ပမာ ဝတ္ထုမှ သိန်းဖေမြင့်၏ လူမှုနောက်ခံဝန်းကျင် ဖန်တီးမှုအတတ်ပညာ ဒေါ်အိဝေဖြိုးအောင်	27
ပင်းယခေတ် မြန်မာကျောက်စာများမှ နာမဝိသေသန အသုံးများလေ့လာချက် ဒေါ်နန်းဆုမွန်ဆွေ	33
Characterization of the Protagonist in Part I from the novel “1984” By George Orwell <i>Daw Sandar Lin</i>	38
Different Usages between American English and British English <i>Daw Tin Tin Aung</i>	43
Exploring Different Types of Writing Business Related Letters <i>Daw Nyein Su Lwin</i>	51
Romanticism As Reflected in the Poem “The Tables Turned” By William Wordsworth <i>Daw Phu Pwint Phyu</i>	59
An Analysis of Conjunctions in the Short Story "Love" by Jesse Stuart <i>Daw Khaing Zin Win</i>	65
SPATIAL DISTRIBUTION OF HEALTH CARE SERVICES WITHIN TAUNGGYI TOWNSHIP <i>Dr. Aye Aye Mauk</i>	71
Geographical Analysis on the development of Road Transportation in Pakokku Township (Before 1988 and 2015) <i>Dr. Myint Zaw</i>	79
A GEOGRAPHICAL STUDY OF WATER SUPPLY SYSTEMS IN KYAINGTONG TOWN <i>Daw Ei Ei Zaw</i>	85
A GEOGRAPHICAL STUDY ON POT INDUSTRY OF WARD NO. 4, KYAINGTONG TOWN <i>Daw Aye Aye Cho</i>	91
URBAN LANDUSE OF YESAGYO TOWN <i>Daw Htet Htet Lwin</i>	97

Computing Heat Equation Using Matlab

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Abstract

In this paper, the heat equation problems are discussed. And then, some theorems, which provided Fourier's series and Finite Element Methods are expressed. We used Matlab's solver to model the heat diffusion and showed graphical solutions for some problems.

Introduction

Partial Differential Equations occur in various physical and engineering problems when the functions involved depend on two or more independent variables. An equation involving one or more partial derivatives of an unknown function of two or more independent variables is called a partial differential equation. The most general second-order linear partial differential equation in two independent variables is

$$a \frac{\partial^2 z}{\partial x^2} + b \frac{\partial^2 z}{\partial x \partial y} + c \frac{\partial^2 z}{\partial y^2} + d \frac{\partial z}{\partial x} + e \frac{\partial z}{\partial y} + fz = g \quad (1)$$

where a, b, c, d, e, f and g are functions of x and y. If $g = 0$, Equation (1) is said to be homogeneous, otherwise, it is non-homogeneous.

Heat Equation

One-dimensional Heat Flow

The flow of heat in a long homogeneous bar (or wire) of length ℓ and cross-section α sq.cm. Let ρ (gm/cm³) be the density, s the specific heat (in cal/gm deg) and k the thermal conductivity of the material. Let one end of the bar be taken as origin, the direction of heat flow along the bar as the X-axis. Assume that the sides of the bar are so insulated that heat flows in the direction of OX only. Let $u(x, t)$ be the temperature at a distance x at time t . It is known that heat flows in the direction of decreasing temperature and also that the rate of heat flow is proportional to the gradient temperature $\frac{\partial u}{\partial x}$. Let PQ be an element of the bar where $P = (x, y)$ and $Q = (x + \Delta x, y)$. The rate of heat flow across an area is proportional to the area and also to the temperature gradient normal to the area. The constant of proportionality is called the

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which is called the one-dimensional heat equation. The constant a^2 is called diffusivity.

To solve equation (3), apply the method of separation of variables. Let the solution of (3) be of the form

$$u = XT$$

where X is a function of x only and T is a function of t only. Then

$$\frac{\partial^2 u}{\partial x^2} = X''T \quad \text{and} \quad \frac{\partial u}{\partial t} = XT'$$

Substituting these derivatives in equation (3),

$$XT' = a^2 X''T$$

$$\frac{T'}{T} = a^2 \frac{X''}{X}$$

Since each ratio must be a constant,

$$\frac{T'}{T} = a^2 \frac{X''}{X} = -p^2 a^2$$

$$\frac{1}{T} \frac{dT}{dt} = -p^2 a^2$$

Integrating both sides

$$T = e^{-p^2 a^2 t}$$

$$a^2 \frac{X''}{X} = -p^2 a^2$$

$$\frac{X''}{X} = -p^2$$

$$X'' + p^2 X = 0$$

$$\lambda^2 + p^2 = 0$$

$$\lambda = \pm pi$$

$$X = C_1 \cos px + C_2 \sin px$$

subject to the conditions

$$u(0,t) = u(1,t) = 0, \quad t > 0$$

$$u(x,0) = 0, \quad 0 < x < 100$$

$$u(0,t) = 0, \quad t > 0$$

$$u(100,t) = 0, \quad t > 0.$$

The constant A has value $0.208 \text{ cm}^2/\text{s}$.

```
>> A=0.208;
syms n x pi
int(100*int(10^(-7)*sin(n*pi*x/100),x,0,100)
c=ans
syms t s
int(exp(-A*n^2*pi^2*(t-s)/100^2)*c,s,0,t)
a=simplify(ans)
s=symsum(a*sin(n*pi*x/100),n,1,10);
s600=subs(s,t,600);
xx=linspace(0,100,201);
plot(xx,subs(s600,x,xx))
ans = -(cos(pi*n) - 1)/(5000000*pi*n)
c = -(cos(pi*n) - 1)/(5000000*pi*n)
ans = (exp(-(13*pi^2*n^2*t)/625000)*(cos(pi*n) - 1))/(104*pi^3*n^3) - (cos(pi*n) - 1)/(104*pi^3*n^3)
a = (exp(-(13*pi^2*n^2*t)/625000)*(cos(pi*n) - 1))/(104*pi^3*n^3) - (cos(pi*n) - 1)/(104*pi^3*n^3)
```

It appears that 20 terms is enough for a qualitatively correct graph at $t=600$.

First, we create the two one-dimensional grids:

```
x=linspace(-5,5,41)';
y=linspace(0,10,41)';
>> [X,Y]=meshgrid(x,y);
>> z=1./(1+(X+0.5*Y).^2);
surf(x,y,z);view(20,45)
```

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