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(viii) $\Rightarrow$ (ix) Let y be any point in Y and each open set U in X with $f^{-1}(y) \in U$.
Then there exists a preopen set A in Y and we obtain
$A = Y \setminus pCl(f(X \setminus Cl(U)))$, by(viii)
$f^{-1}(A) = X \setminus f^{-1}(pCl(f(X \setminus Cl(U)))) \subseteq X \setminus f^{-1}(f(X \setminus Cl(U))) \subseteq Cl(U)$.
(ix) $\Rightarrow$ (i) Let U be any set in X and F be a closed set in X. Suppose that $F = Cl(U)$ and $y \in Y \setminus f(Cl(U))$. Since $f^{-1}(y) \subseteq X \setminus Cl(U)$, then there exists a preopen set A in Y with $y \in A$ and $f^{-1}(A) \subseteq Cl(X \setminus Cl(U)) = X \setminus Int(Cl(U))$.
Therefore, $A \cap f(Int(Cl(U))) = \phi$, and $y \in Y \setminus pCl(f(Int(Cl(U))))$. So, we obtain
$pCl(f(Int(Cl(U)))) \subseteq f(Cl(U))$.

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 our respectable Professor Dr. Moe Moe San, Head of Department of Mathematics, Yangon University of Distance Education, for her kind permission and encouragements throughout this research paper.

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Functions and Their Graphical Representation

Ohnmar Myint[1], Moe Moe San[2], Zar Chi Saint Saint Aung[3]

Abstract

In this paper we shall define one of the most fundamental concepts in mathematics, the notation of a function. We shall discuss the notation used to describe functions and investigate some of their graphs.

Key words: Function, graph, relation, domain, range.

Introduction

In mathematics, the concept of a function is very important and useful. It appears in almost every branch of the subject. We shall use the word *function* to denote a certain specific type of correspondence or association between the elements of two sets. And then, we shall show how to represent a functions geometrically by graphs. Such graphs provide a useful way of visualizing the behavior of a function. We shall also develop some basic techniques for using graphs of simple functions to constant graphs of more complicated functions.

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The concept of a function and its graph

The term "function" was first used by Lebriz in 1673 to denote the dependence of one quantity on another.

The area of a circle depends on its radius r by the equation $A = \pi r^2$,so, we say that "A is a function of r".

The velocity V of a ball falling freely in the earth's gravitational field increases with time t until its hits the ground, so we say that "V is a function of t".

In general, if a quantity y depends on a quantity x in such that each value of x determine exactly one value of y then we say that "y is a function of x".

Definitions

If there is associated with each element of a set *X* exactly one element of another set *Y*, then this association constitutes a functionfrom *X* to *Y*, usually written $f : X \to Y$. The set of *X* is called the ***domain*** of the function *f* and the set *Y* is called its ***range***.

If the letter f to denote a function then the equation *y=f* (*x*), the quantity *x* is called the ***independent variable*** of *f* and the quantity *y*, the ***dependent variable*** of f.

x and *y* may represent a numerical quantities, but f itself does not represent a numerical quantity, it stands for a "relationship between *x* and *y*".

For example: $y= 100 - 4x^2, 0 \le x \le 5$. The domain of the function is the set $\{x : 0 \le x \le 5\}$ and the range of the function is the set $\{y : 0 \le y \le 100\}$.

For example,consider the unit circle and its equation $x^2 + y^2 = 1$ and then $y = \sqrt{1 - x^2}$. In the equation $y = \sqrt{1 - x^2}$, the domain is the set $X = \{x | x \in R \text{ and } -1 \le x \le 1\}$ and the range is the set $Y = \{y | y \in R \text{ and } 0 \le y \le 1\}$.

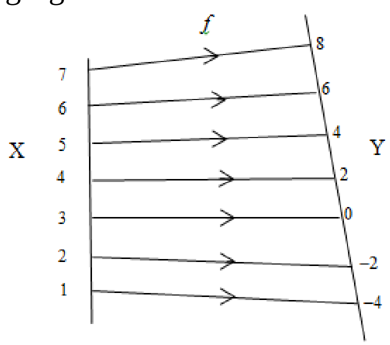
Note: The important points are that a function pairs one and only one element of *Y* with each element of *X***.**

Definition: An important and yet almost trivial, function is the one which associates all real numbers with the same fixed number. Such a function, called a ***constant function***, written $f : x \to c, c$ is constant.

Definition: A function from *X* to *Y* is a set of ***ordered pairs*** (*x*, *y*) such that to each $x \in X$, there corresponds a unique $y \in Y$. We may use the set notation to describe a function $\{(x, y) | y = f(x)\}$.

Definition: The graph in the *xy*-plane of a function f is defined to be the ***graph*** of the equation *y=f* (*x*).

Consider the function defined by the equation $y = 2x - 6$ for all positive integers less than 10, where X = {1, 2, 3,..., 9}.For this function, $f(1) = -4$, $f(2) = -2$, and so on. The function *f* is illustrated in the following figure.



Examples for some graphs of function

The domain of *X*, of *x*-values, the range *Y*, the set of *y*-values and the rule, relationship or correspondence which associated these two sets in a certain way. Unless otherwise state, both domain and range of any function will be the largest possible set of suitable real numbers.

Consider, the graph of $f(x)=|x|, y=f(x)=\begin{cases}-x, & x<0\\ x, & x\geq 0.\end{cases}$

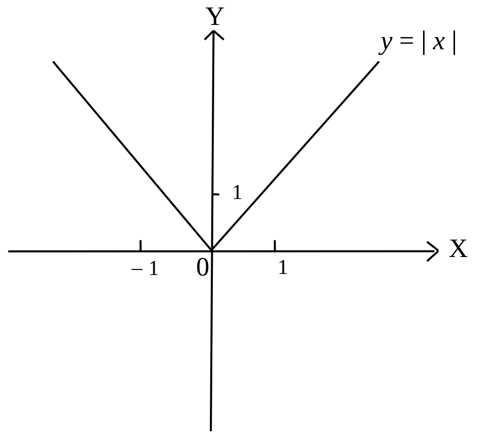


Figure (i)

Consider, the graph of $f(x)=x^2$.

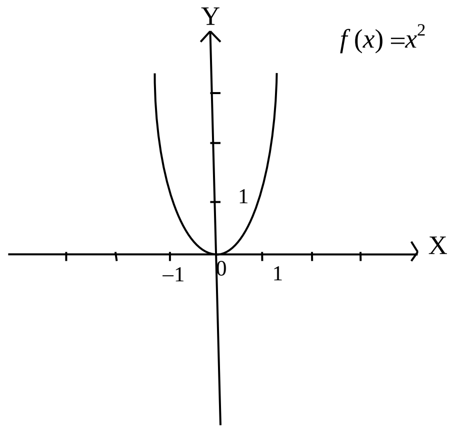


Figure (ii)

The graph of $f(x)=\sqrt{x}$.

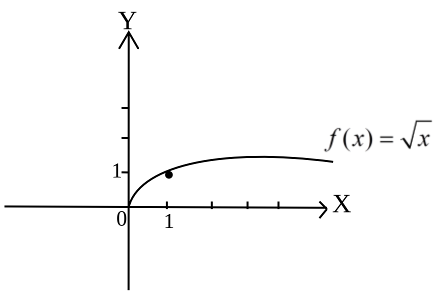


Figure (iii)

The graph of $f(x) = x^3$.

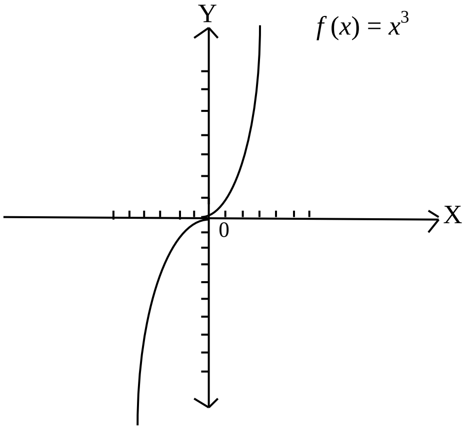


Figure (iv)

The graph of $f(x) = x^4$.

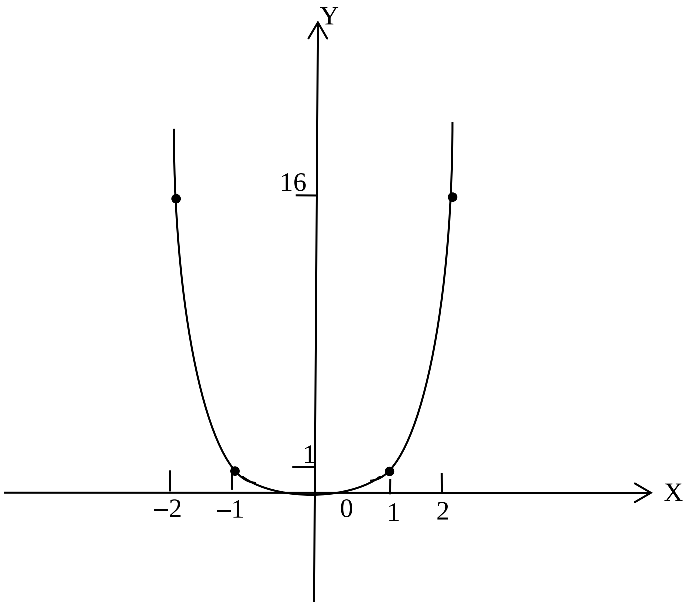


Figure (v)

Graphical representation of functions

Using the rectangular coordinate system, we are able to exhibit the association between x and y (or any two variables) in the case of any particular function.

Linear functions and its graphs

The slope of a nonvertical line passing through the two points (x_1, y_1) and (x_2, y_2) is the number m defined by, $m = \dfrac{y_2 - y_1}{x_2 - x_1}$.

We denote, change in x by $\Delta x = x_2 - x_1$ and Δy change in y, $\Delta x = y_2 - y_1$. So slope, $m = \dfrac{\Delta y}{\Delta x}$.

Comparing slopes:There are positive slope, negative slope, horizontal lines slope and vertical lines slope.

The point-slope formula: An equation of the line with slope m passing through the point (x_1, y_1) is $y - y_1 = m(x - x_1)$.

The slope intercept formula; $y = mx + b,$ m is slope and b is the point of y-intercept.

The general forms of straight line: Ax + By + C = 0, A, B and C are constants.

Let m_1 and m_2 denote the slopes of two distinct nonvertical lines. Then the lines are parallel if and only if $m_1 = m_2$ and the lines are perpendicular if and only if $m_1 = -\frac{1}{m_2}$.

Note (i) Two lines are parallel then this two lines are no intersect and no solutions.
(ii) Two lines are intersect, the solution is unique.
(iii) Two lines are the same, the solution is many.

To find an equation for the line passing through the two points (4, 8) and (–3, –6) the graph of its equation:

slope: $m = \frac{-6-8}{-3-4} = \frac{-14}{-7} = 2$

equation:
$$y - y_1 = m(x - x_1)$$
$$y - 8 = 2(x - 4)$$
$$y = 2x - 8 + 8$$
$$y = 2x$$

x	0	–1	1	2
y	0	–2	2	4

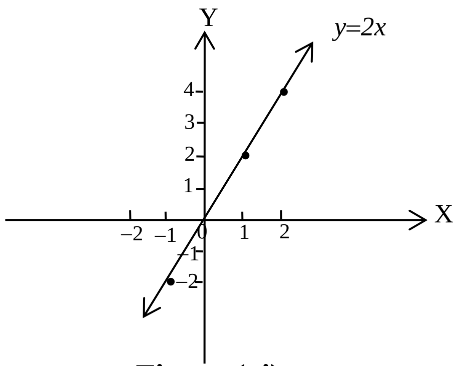


Figure (vi)

Quadratic functions and its graphs

A quadratic function is an equation that can be written in the form $ax^2 + bx + c = 0,$ where a, b and c are real numbers and $a$is not zero. We solved quadratic equations in two ways, by factions and by quadratic formula. The quadratic formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. If $b^2 - 4ac > 0,$ then the two distinct real solutions, if $b^2 - 4ac = 0,$ then the one real solution and if $b^2 - 4ac < 0,$ then the two complex solutions.

To solve quadratic equations $4x^2 - 12x + 9 = 0$.

(i) By factoring; $4x^2 - 12x + 9 = 0$ (ii) By quadratic formula; $x = \frac{-(-12) \pm \sqrt{(-12)^2 - 4(4)(9)}}{2(4)}$

$$(2x-3)(2x-3) = 0 \qquad x = \frac{12 \pm \sqrt{144-144}}{8}$$

$$(2x-3)^2 = 0 \qquad x = \frac{12}{8} = \frac{3}{2}.$$

$(2x-3) = 0$ and $x = \frac{3}{2}$.

The graph of quadratic equations $4x^2 - 12x + 9,$

x	0	1	2
y	9	1	1

Vertex: $x=\dfrac{-b}{2a}=\dfrac{-(-12)}{2(4)}=\dfrac{12}{8}=\dfrac{3}{2}$, $y=4\left(\dfrac{3}{2}\right)^2-12\left(\dfrac{3}{2}\right)+9=0$

Symmetry line: $x=\dfrac{3}{2}$.

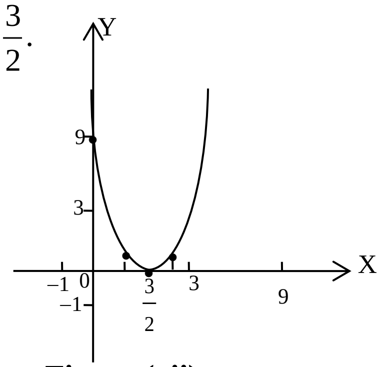


Figure (vii)

Some other functions and its graphs:

The function represented by the set of ordered pairs $\{(x, y)|y=|3x-2|\}$. We construct the table.

x	-1	0	1	2	3
y	5	2	1	4	7

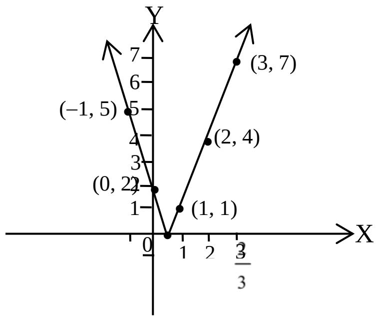


Figure (viii)

For inequality function$y\leq x+5$, for the graph of the relation, we first plot the line $y=x+5$ and then realize that for any particular x the point (x, y) is a member of the required set if its y- coordinate is equal to or less than it would be if the point lay on the line. The required set is thus the line $y=x+5$, and all points below this line. The shaded area indicates the graph of this relation. We construct the table.

x	−5	−2	0	2
y	0	3	5	7

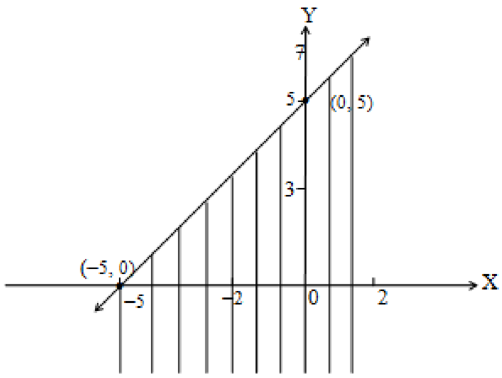


Figure (ix)

Acknowledgements

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Trilinear and Quadrilinear Forms

Wai Wai Tun[1], Aye Aye Maw[2]

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 Ω be a Lipschitz open bounded subset in $\mathbb{R}^n$. We shall use the notation of the spaces V={$u\in$ D (Ω), *div* $u=0$}, $\boldsymbol{V}$ = the closure of V in $H_0^1(\Omega), H$ = the closure of V in $L^2(\Omega)$, W = D (Ω), 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* $u:[0,T] \to H$ *is continuous a.e and*

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

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

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