

Mathematics for everyday life

Dr Kirthi Premadasa



A couple of decades ago if one asks the question, “what is mathematics useful for?”, the answer will be very clear: “It is a must for engineering!”. This was of course the primary reason why Sri Lankan students are loaded with quite an advanced mathematics screening at the Advanced Level examination.

However there is an irony in all this. Though a small minority of the students who follow and excel in A/level mathematics, do end up as engineers and use the mathematics that they have learnt in their workplace, the vast majority of the students (those who do not gain admission to Engineering or Science Faculties) end up “dropping” their mathematics at A.level, making years of state investment in mathematics education a total waste.

However, since recent times, emphasis has been made to highlight applications of mathematics in non-engineering areas such as finance, insurance, economics, biology etc.

Lets us look at some simple examples from everyday life. Lets go to the marketplace and see how mathematics can be used for the purchase of apples. You see two types of apples in the store. A smaller type (say Type A) and a bigger type (say Type B). To your eye it seems that the radius of the bigger apple is about twice as much as the smaller apple.

The vendor says that the smaller apple cost Rs. 25 and the bigger apple costs Rs. 70. Would you buy two of the smaller apples or one big apple ?

When you are faced with this option it seems that since the two smaller apples cost Rs 50, it appears that buying one big apple at Rs 70 is really not worthwhile.

However, mathematics says something different. An apple can be thought of roughly as a sphere and what you eat is the volume. Recall that the volume of a sphere of a radius r is given by the formula

$$V = \frac{4}{3} \pi r^3$$

Notice that the volume formula carries a r^3

term. What does this say? This says that if the radius is doubled, then the volume is increased by $2^3 = 8$ times. Which means that the bigger “looking” apple has about 8 times more volume than the smaller apple. So actually the bigger apple is worth around Rs 200. So buying the bigger apple for Rs. 70 is a really good deal!

Another place you can start using your mathematics knowledge is when laying the floor and painting your houses. Most of the painters and masons laying the floor give you a “per square feet” rate. So to calculate the total cost, you need to calculate the area accurately to ensure that you have the accurate cost estimate.

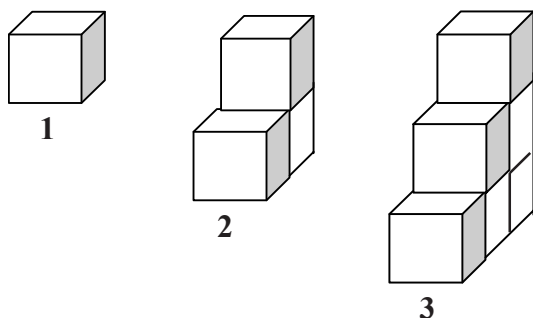
No matter how complicate an area is you can calculate it by breaking up in to squares, rectangles, trapezoids, circles,

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ellipses etc. So if you know how to calculate the areas of these basic shapes then you can combine them to get the area of the more complicate shapes.

We will leave the following “painting” problem as an exercise to the reader.

Same sized cubes are glued together to form a staircase as shown below.



For example, a staircase of 2 steps is created by 3 cubes glued together. A staircase of 3 steps is created by 6 cubes glued together.

All of the unglued faces of the cubes need to be painted. The reader can find the number of squares that needs to be painted in a staircase which has 20 steps (or any number of steps for that matter).

Another area where mathematics enter the day-to-day life is in finance. There is a lot of mathematics involved in loan calculations as well as in the calculation of Bond and Option prices. Lets take a look.



Suppose you want to get a car loan for 1 million rupees at a 12% fixed annual interest rate to be paid in 4 years. You would want to see what the monthly installment could be. This type of problems appears as a standard problem in financial mathematics under annuities.

For a simple loan with fixed payments and fixed interest rate, the monthly payment m can be calculated by the following formula (assuming payments are made at the end of each period).

$$m = \frac{-rL(1+r)^n}{((1+r)^n - 1)}$$

Here

L = Loan Amount

r = Monthly interest rate (as a decimal)

n = Number of months

So for the above example, $L=1000000$, $r=0.12/12$ and $n=48$. Putting these in the above formula, we get the monthly payment $m = -26,333.84$ (The minus sign reflects that we make the payment). So even before you go to the car leasing company, you have a pretty good idea what installment you have to pay.

At this time you may think that even if you do not know the mathematics behind this, by simply substituting the values for the loan, interest rate and the number of months, you can arrive at the monthly payment. It is true, if the case is straightforward. However if you need to make an adjustment on the schedule (say remove the April payment on account of the Sinhala New year), then the above formula will no longer work as it is. You must then know the mathematical theory behind the formula to calculate the monthly payment.

Therefore it is important for students who plan to specialize in finance to have a solid mathematical background to understand the mathematics behind the formula.

Another “hot” area that has created a severe demand for good mathematicians is in option pricing. An option is a contract between two persons (a buyer and a seller) which gives the right (but not an obligation) to the buyer to buy or sell the underlying asset at an agreed price before the date of expiry of the

contract. Lets try to explain this in simple language.

Suppose you are interested in buying an asset between this June and the end of year. If you buy an option for this asset, then you get the right to buy this asset at an agreed price before the period is over. However if you do not want to buy this, then you can stay without buying it. For having the right but not the obligation, you will have to pay some money to buy this contract (option).

The price of this option is calculated using very heavy mathematics and comes as a solution of a second order partial differential equation called the Black Scholes differential equation. If you need to fully understand the pricing of options, you should have a good grasp of solving second order partial differential equations which is today covered in the mathematics curriculum in most good universities. The massive interest in option pricing all over the world has resulted in financial companies hiring good mathematicians to their teams.

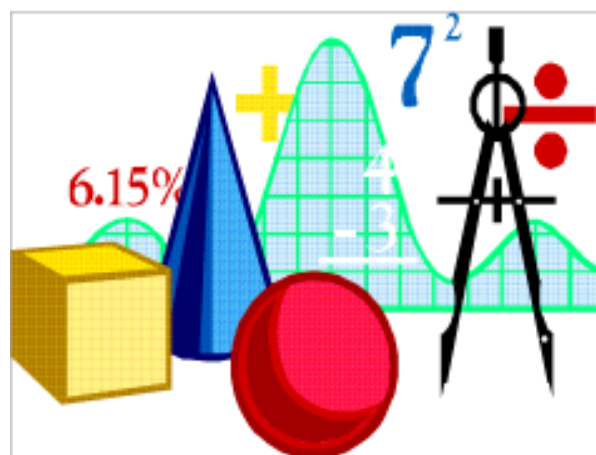
Another area that mathematics is intensively applied is in the field of insurance. When you buy an insurance policy, based on your profile, the insurance agent comes up with a premium that you need to pay every month.

The calculation of this premium involves complex mathematics and the subject is called Actuarial Science. To be an actuary, one must have a strong background in mathematics as well as statistics. The Actuarial profession in Sri Lanka is severely understaffed and offers excellent opportunities to students who are strong in mathematics to find lucrative employment.

Advanced Level students who are reading this article will be familiar with the maxima and minima curve sketching that is done for calculus. What is done there is to find the maximum and minimum points of a given function. This is yet again another strong application area in mathematics. In real life examples, differentiation is used to find the points where profit and revenue are maximized and cost is minimized. Even though in the Advanced level curriculum, you only handle functions of a single variable, you can without much difficulty extend the techniques to many variables.

As an example, suppose the revenue R of a certain product is a function of both the capital investment K and the labour cost L . By using calculus, one can find the values of K and L which optimize the revenue.

Sometimes optimization is required under a constraint. For example, suppose we need to create a cylindrical can to store a beverage. Suppose we have a constraint that the cylinder must contain 400 ml of beverage. Subject to this constraint we need to minimize the cost of manufacturing the cylinder. In other words we want to minimize the surface area of the cylinder given by $A = 2\pi rh + 2\pi r^2$, where r is the radius of the cylinder and h is the height of the



cylinder. However there is a constraint on the volume given by $\pi r^2 h = 400$.

We need to find r and h which minimize the surface area A subject to the given constraint. This type of constrained optimization problem can be solved using a technique known as Lagrange multipliers. This technique is well known in Engineering and Micro Economics.

We will end this article using another application in finance. Suppose you are planning to make an investment. You know the saying “Do not put all your eggs in to the same basket”. So you are planning to invest in several investments creating an investment portfolio. Now you need to know how much to invest in each investment in the portfolio. Each of the different investments carry a different return and a risk. So how should you invest? Well you must invest in a manner so that your total return is maximized while the total risk is minimum.

Finding this optimum investment portfolio is called portfolio investment and this process involves a lot of advanced mathematics.

As you can see from the above, applications of mathematics have now found their way in to almost every possible subject area, and no matter whether you are buying apples in the marketplace, painting your house or planning a car loan, mathematics will come to your assistance in a significant manner.

Dr Kirthi Premadasa PhD (Purdue)
Senior Lecturer in Mathematics
University of Colombo