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Teaching Engineering Mathematics Dilemma

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Abstract: In this paper, the dominant trends of present-day mathematics has been studied and a suggestion for principles that should govern the choice of contents and the method of teaching mathematics at the secondary and university levels has been given depending on the experience of teaching two books on using Matlab and Mathematica softwares.

Key words: Engineering mathematics, Matlab, teaching mathematics, calculus, differential equations, electric circuits.

1. Introduction

Many engineering students have fewer marks in their University Mathematics than their marks in School Mathematics. Is it due to the advanced level of mathematics at the university or the method of teaching and evaluation?

In 2007, two books were published: *Matlab Guide for Mathematics at the University* [1] and *Mathematica Guide for University Mathematics* [2]. The first one is to help students solving the mathematical problems using Matlab and the second boo was also to help students solving the mathematical problems using Mathematica. The following common question was present depending on the experience of teaching these two books [3]:

Can someone be an engineer if he has no good knowledge in Math?

This kind of question seems to come up a lot for people teaching or studying engineering Mathematics. In some cases, people think they need to be geniuses in mathematics.

Nevertheless, some problems need at least the basic mathematical concepts, graphing, and sometimes physics concepts.

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2. Methods and Contents of Engineering Mathematics Courses

Some examples are given below to help answering the following questions:

Could Engineering Students avoid the abstract and theoretical mathematics?

Is it required, to teach students how to use the calculator and the mathematical software, such as Matlab?

What are the Engineering Students obstacles?

What is the best Engineering Mathematics plan?

2.1 Example1 (using the Calculator right)

Find the area of the propeller-shaped region enclosed by the curve

$x - y^3 = 0$ and the line $x - y = 0$.

Using the calculator, we can find the intersection points (How).

Now the areas using the Calculator (definite integral key $\int_a^b f(x)dx$) or

using the Matlab command:

symsx; solve('x^(1/3)-x', x),

the answer will be 0 and 1.

Then we find the area using the command:

syms x y; int('x^(1/3)-x', x, 0, 1)

The answer will be 1/4.

Notice:(i) Do we need graphing?

If we use the command:

syms x y; int('x^(1/3)-x',x,0,1), the answer will be -1/4.

The difference is just the sign, no panic once you know that happens because we interchanged the higher curve with the lower one.

2.2 Example 2

In this example, the calculator could not help without differentiation background.

Applying the Arc Length Formula [4]:

$$L = \int_a^b \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dx$$

to find the length of the curve

$$y = \frac{4\sqrt{2}}{3} x^{\frac{3}{2}} - 1, 0 \le x \le 1,$$

the answer will be the result of the definite integral

$$L = \int_0^1 \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dx.$$

Can you use the calculator now?

No, why?

Note that the derivative key in your calculator ($\frac{dy}{dx}$) gives the first derivative at a given value of the independent variable of the function that describes the curve (the slope). So, you need the first derivative done by hand.

Now, you can use your calculator to find the length of the curve

$$L = \int_0^1 \sqrt{1 + 8x}\, dx$$

which is using the Calculator (definite integral key $\int_a^b f(x)dx$).

But, we get the result in one go, using the following Matlab command:

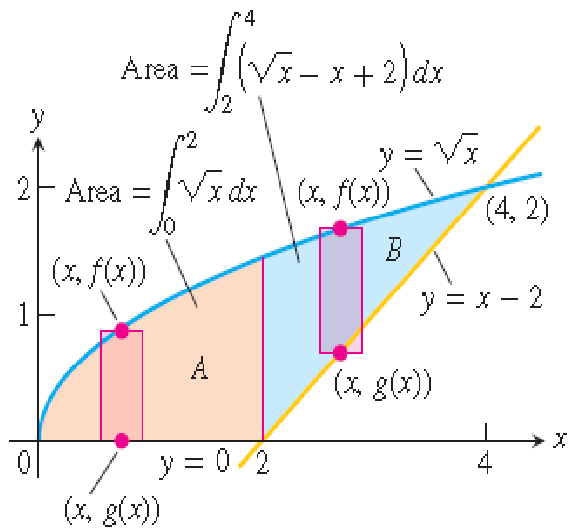
symsx;

int(sqrt(1+(diff(((4*sqrt(2))/3)*x^(3/2)-1))^2),x,0,1), which gives the value 13/6.

2.3 Example 3

This example is to answer the question *Is Graphing necessary?*

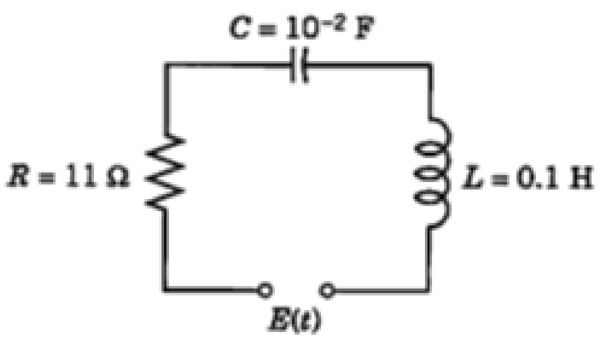
Find the area of the region in the first quadrant that is bounded above by $y = \sqrt{x}$ and below by the x-axis and the line $y = x - 2$.



It is clear that graphing is necessary, as the intersection point between the line and the parabola is not enough to find the requested area.

2.4 Example 4

Physics comes first in this example. Find the response (the current) of the RLC-Circuit



$E(t) = 100\sin(400t)$ if $0 < t < 2\pi$ and $E(t) = 0$ if $t > 2\pi$ and current and charge are initially zero [5]. The following Electrical physics lows are essentially:

Ohm's low RI is the voltage drop for a resistor of resistance R ohm,

$L\frac{dI}{dt}$, the voltage drop for an inductor of inductance L hennery,

$\frac{Q}{C}$, the voltage drop for a capacitor of capacitance C farad,

Q coulomb is the charge on the capacitor, related to the current by $I(t) = \frac{dQ}{dt}$, equivalently, $Q = \int I(t)dt$,

Kirchhoff low is the key and the concept of the Unit Step (Heaviside) Function which give the following mathematical modelling for the given circuit

$$0.1\frac{d^2i}{dt^2} + 11\frac{di}{dt} + 100i = 100\sin(400t)[1 - U(t - 2\pi)],$$
$$i(o) = 0, \left.\frac{di}{dt}\right|_{t=o} = 0$$

which is an Ordinary Differential Equation with initial condition.

Now, we can use the mathematics software. Let us use the MATLAB Command:

syms t I;
I=dsolve('0.1*D2i+11*Di+100*I)=
(100*sin(400*t))(1-heaviside(2*pi))',
'D2i(0)=0','D2i(0)=0','t')

Make the outecoe result readable by the command:

```
>> pretty(i)
```

You have the mathematics mode (Fig. 1):

```
exp(-100 t) (- 4/153 + 4/153 heaviside(2 pi))

                   / 400      400                    \
     + exp(-10 t) |----- - ----- heaviside(2 pi)|
                   \14409   14409                    /

          159   /44                        \
     + ----- |--- cos(400 t) + sin(400 t)| (-1 + heaviside(2 pi))
        27217 \159                         /
```

Fig. 1 Mathematics mode.

Fig. 2 Three parts.

3. Conclusion:

Finally, we need to concentrate on the concepts and how adopt the solution technique avoiding the theoretical calculation steps.

Mathematical background and mathematical software skill are necessary in solving Mathematical Problems in different areas.

Engineering Mathematics course description should be three parts. The first is teaching the mathematics concept and its link to the students' field. The second part is how to use the tools to solve the mathematical problems. The third includes some applications (Fig. 2).

Evaluating Engineering Mathematics is up to the ability to use the mathematical concepts in the field and how to use the mathematics software in problem-solving.

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