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Advanced Engineering Mathematics: An Overview

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ABSTRACT

It was showed that students will struggle with new concepts in Engineering Mathematics and faced difficulties with the need to use various mathematical techniques to solve problems. Thus, this embarked to improve our teaching and students' learning. It is however worth noting that for quite some time applied mathematics has had more practical applications than theoretical ones, especially in mechanical engineering. We used an action research perspective as various methods within this stance can ensure flexibility in responding to the dynamics of interaction between the teachers and the students. This paper will present an account of our study and highlight various topics related to Advance Engineering Mathematics.

Keywords- Advanced Engineering Mathematics, Integration, Differentiation, Matrix

I. INTRODUCTION

Engineering mathematics is a branch which helps us to understand mathematics concepts, mathematical methods and techniques that are typically used in engineering and industry. The formation of mathematics as an applied branch at the service of the engineer is not a modern invention: the art of making calculations is as old as humankind, and its practitioners have been divided into a number of different groups (alchohol-makers, stonecutters, builders and musicians), many of which have also been found in adjacent areas such as medicine or astronomy. It is however worth noting that for quite some time applied mathematics has had more practical applications than theoretical ones, especially in mechanical engineering.

As we know, engineering physics and engineering geology, these two may belong in the wider category engineering science, engineering mathematics is a subject motivated by engineers' needs both for practical, theoretical ,outwith their specialization, and to deal with constraints to be effective in their work. Engineering mathematics overlaps with other engineering sciences, and it can be close to the field of theoretical computer science.

Advanced Engineering Mathematics includes:

a) Simple and partial or complicated differential equations
b) Integration
c) Matrix in maths
d) Fourier series' numerical concept and transforms in engineering maths

Powered by TCPDF Simple and partial or complicated differential equations:

Simple differential equation:

Simple also known as o*rdinary or normal differential equations* are equations in which derivatives are taken with help of only one variable. So, there is only one variable which is independent

Complicated differential equation in maths:

Complicated also known as partial *differential equations* are equations in which derivatives are taken with help of several variable. So, there are several variables which are independent

Some of the methods and concepts used in differentiation:

Differentiation

$(cu)' = cu'$ (c constant)

$(x^n)' = nx^{n-1}$

$(e^x)' = e^x$

$(e^{ax})' = ae^{ax}$

$(a^x)' = a^x \ln a$

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$$(u+v)' = u' + v'$$

$$(uv)' = u'v + uv'$$

$$\left(\frac{u}{v}\right)' = \frac{u'v - uv'}{v^2}$$

$$\frac{du}{dx} = \frac{du}{dy} \cdot \frac{dy}{dx} \quad \text{(Chain rule)}$$

$$(\sin x)' = \cos x$$

$$(\cos x)' = -\sin x$$

$$(\tan x)' = \sec^2 x$$

$$(\cot x)' = -\csc^2 x$$

$$(\sinh x)' = \cosh x$$

$$(\cosh x)' = \sinh x$$

$$(\ln x)' = \frac{1}{x}$$

$$(\log_a x)' = \frac{\log_a e}{x}$$

$$(\arcsin x)' = \frac{1}{\sqrt{1-x^2}}$$

$$(\arccos x)' = -\frac{1}{\sqrt{1-x^2}}$$

$$(\arctan x)' = \frac{1}{1+x^2}$$

$$(\operatorname{arccot} x)' = -\frac{1}{1+x^2}$$

II. INTEGRATION

As we know, Integration is the method to solve an integral. Integrals in maths are used to find quantities or values like areas, volumes, displacement, etc. In other words, Integration is from the two most important topics in Mathematics, apart from differentiation. When we study integrals, it is related to definite integrals. These indefinite integrals are used for, to find antiderivatives.

In Maths, integration is a method of adding or cal. to find a particular value. this can be reverse process of differentiation, where we reduce the functions into parts, this type of method is used to find the summation under a vast scale.

Integration

$$\int uv'\,dx = uv - \int u'v\,dx \text{ (by parts)}$$

$$\int x^n\,dx = \frac{x^{n+1}}{n+1} + c \qquad (n \neq -1)$$

$$\int \frac{1}{x}\,dx = \ln|x| + c$$

$$\int e^{ax}\,dx = \frac{1}{a}e^{ax} + c$$

$$\int \frac{dx}{\sqrt{a^2 - x^2}} = \arcsin\frac{x}{a} + c$$

$$\int \frac{dx}{\sqrt{x^2 + a^2}} = \operatorname{arcsinh}\frac{x}{a} + c$$

$$\int \frac{dx}{\sqrt{x^2 - a^2}} = \operatorname{arccosh}\frac{x}{a} + c$$

$$\int \sin^2 x\,dx = \tfrac{1}{2}x - \tfrac{1}{4}\sin 2x + c$$

$$\int \cos^2 x\,dx = \tfrac{1}{2}x + \tfrac{1}{4}\sin 2x + c$$

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$$\int \sin x\,dx = -\cos x + c$$

$$\int \cos x\,dx = \sin x + c$$

$$\int \tan x\,dx = -\ln|\cos x| + c$$

$$\int \cot x\,dx = \ln|\sin x| + c$$

$$\int \sec x\,dx = \ln|\sec x + \tan x| + c$$

$$\int \csc x\,dx = \ln|\csc x - \cot x| + c$$

$$\int \frac{dx}{x^2 + a^2} = \frac{1}{a}\arctan\frac{x}{a} + c$$

$$\int \tan^2 x\,dx = \tan x - x + c$$

$$\int \cot^2 x\,dx = -\cot x - x + c$$

$$\int \ln x\,dx = x\ln x - x + c$$

$$\int e^{ax}\sin bx\,dx = \frac{e^{ax}}{a^2 + b^2}(a\sin bx - b\cos bx) + c$$

$$\int e^{ax}\cos bx\,dx = \frac{e^{ax}}{a^2 + b^2}(a\cos bx + b\sin bx) + c$$

III. MATRICES AND LINEAR ALGEBRA

A matrix is an m × n array of scalars from a given fields (field – are deffine as rows and columns). The individual values in the matrix are called entries.

Matrix rules

scalar multiplication

$$n\begin{bmatrix} a & b & c \\ d & e & f \end{bmatrix} = \begin{bmatrix} na & nb & nc \\ nd & ne & nf \end{bmatrix}$$

matrix addition

$$\begin{bmatrix} a & b \\ c & d \\ e & f \end{bmatrix} + \begin{bmatrix} g & h \\ i & j \\ k & l \end{bmatrix} = \begin{bmatrix} a+g & b+h \\ c+i & d+j \\ e+k & f+l \end{bmatrix}$$

matrix multiplication

$$\begin{bmatrix} a & b & c \\ d & e & f \end{bmatrix}\begin{bmatrix} g & h \\ i & j \\ k & l \end{bmatrix} = \begin{bmatrix} ag+bi+ck & ah+bj+cl \\ dg+ei+fk & dh+ej+fl \end{bmatrix}$$

Fourier series' numerical concept and transforms in engineering maths:

Fourier series' numerical concept and transforms in engineering maths. Methods for Partial Differential Equations is a valuable resource for researchers and practitioners in the fields of maths, scienceand engineering who work with mathematical modeling of physical process, including subject like diffusion and wave aspects

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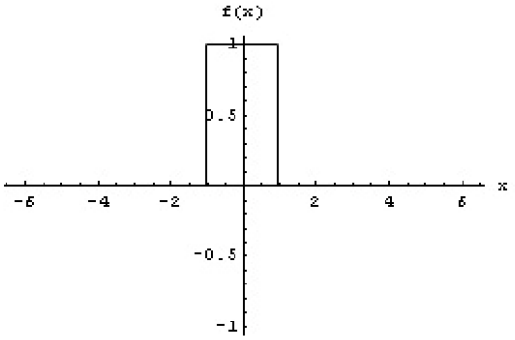
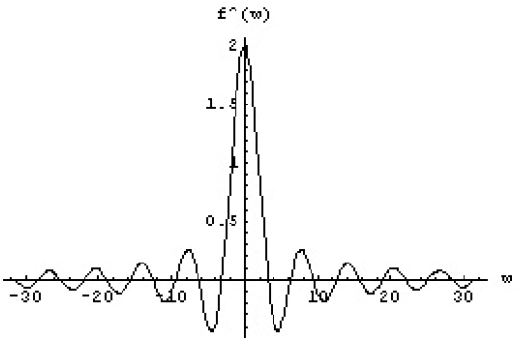
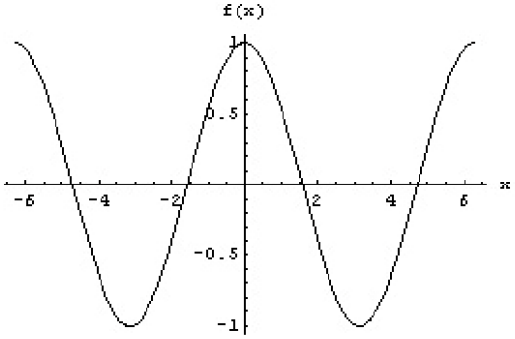
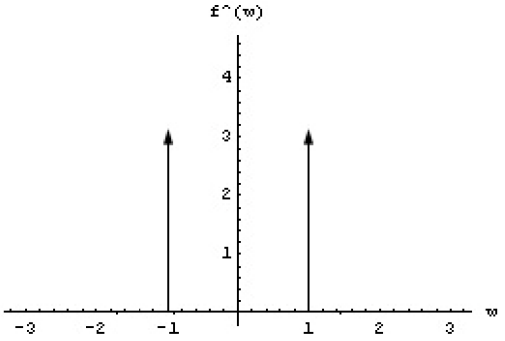
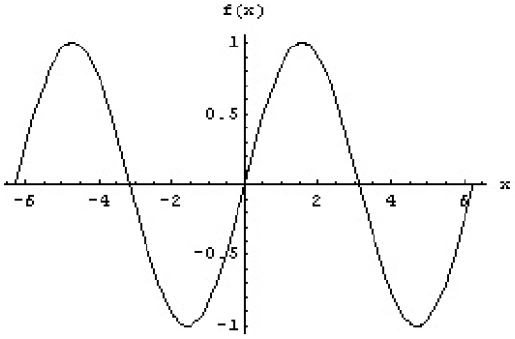
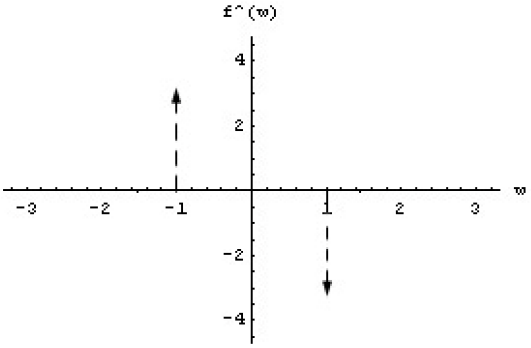
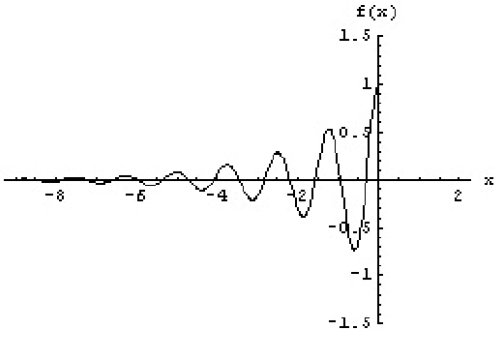
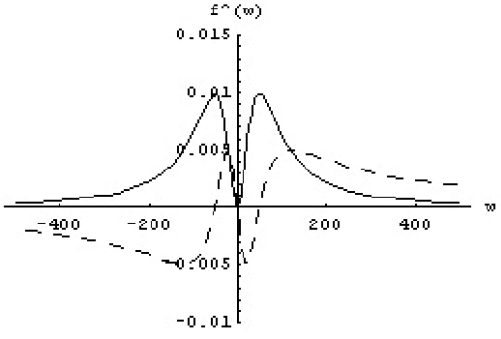
Table 1: Sample functions (Left) and their Fourier transformation (Right).

[1] $f(x)=\begin{cases}1, & x<\lvert 1\rvert \\ 0, & elsewhere\end{cases}$ 	$f\hat{}(\omega)=\dfrac{2\sin(\omega)}{\omega}$ 
[2] $f(x)=\cos(x)$ 	$f\hat{}(\omega)=\pi\left[\delta(\omega-1)+\delta(\omega+1)\right]$ 
[3] $f(x)=\sin(x)$ 	$f\hat{}(\omega)=i\pi\left[\delta(\omega+1)-\delta(\omega-1)\right]$ 
[4] $f(x)=\begin{cases}e^{x/2}\cos(5x), & x\le 0 \\ 0, & \text{elsewhere}\end{cases}$ 	$f\hat{}(\omega)=\dfrac{2(1-2i\omega)}{100+(1-2i\omega)^2}$ 

Importance of Advanced Engineering Mathematics:

From a hiearchical view, the division of engineering mathematics is not very clear. The well-known textbooks on engineering mathematics do not define it well. It is clear that the division depends a lot on the context in which one looks at engineering mathematics. Some authors consider mathematics as a branch of applied geometry, and others limit it to its more applied area, namely mathematical analysis; others consider it as a branch of applied statistics and simulation theory; still others consider it as a part of numerical analysis and its applications; other authors include in their definition many distinct areas that were previously considered separately, such as combinatorial optimization or Computer-aided Engineering.storical perspective, the 20th century saw two areas of mathematics gain prominence in their use within engineering

Key points about Advanced Engineering Mathematics are:

Advanced Engineering Mathematics is a course for people who want to pursue a career in engineering. The course includes topics such as Calculus, Differential Equations and Linear Algebra.

Strategies for the design and analysis of digital computer systems are discussed by means of computer modeling, boundary value problems, and various other methods. Methods include finite element method, analysis such as (for example) the Laplace transform or the eigenvalue problem, as well as various Monte Carlo methods. Examples include a digital circuit simulator based on recursive calls to a quasistatic finite element algorithm; and quantitative modeling of hybrid engine systems using a digital simulation code. These can be linked not just to real system but also to approximate solutions like "methods for analyzing multiple-input multiple-output data processing systems", which include considerations such as memory constraints.

Mathematics is a fundamental part of engineering. It is what shapes the world around us. Engineers are constantly faced with problems which they need to solve and the most common way to do so is through mathematics.

IV. CONCLUSION

In this cross-sectional study, we aimed to understand the factors that, Advanced engineering mathematics is a branch of mathematics that is concerned with the study, analysis and application of mathematical methods for solving problems in engineering.

It includes, but is not limited to, the study of differential equations, integral equations, functional analysis and linear algebra as they are applied to engineering problems.

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