Why should I buy this Mathematical Handbook?

It is reasonable for anyone to ask whether it is necessary to have this **Mathematical Handbook**. Some reasons to support the usefulness of this book are presented here for anyone to consider.

The first question a prospective user should ask himself is the following: "Do I use mathematics in some form or another?" The second question is the following: "As a **professional** do I often use mathematics?" The third question is the following: "As a **student** do I often need help in various branches of mathematics?"

If the answers contain at least one "Yes", then you will need this book many times in your lifetime. If there are two "Yes", then this book is a necessity. If there are three "Yes", then it is an absolute must. Below we give the main reasons why this is so.

This **Mathematical Handbook** is a **concise reference** for many branches in mathematics. It facilitates the user to have a **strategic overview** of the subject, have some **compact information** about it, and then **focus on the particular point** he is interested in. It gives the amount of information the user needs in most cases. If the user needs more information, he can go to the **additions** that contain material in more details even than many textbooks specializing on a particular topic. Thus the whole informational structure can be viewed as through a magnifying glass of increasing magnification.

In the design of this **Mathematical Handbook** we have tried to incorporate many demands: The user wants to have **precise** and **reliable** information **as fast as possible**. He does not want to plunge into a labyrinth of data or to remember complicated instructions in order to access this information. A book of at most 500 pages is the maximum most users can easily handle. At the same time, he does not want to give up his right to information contained in ten times larger books or even whole libraries. This book is the first one that gives this **flexibility** to the user. Its material in Part A is less than 350 pages, together with Part C is about 1000 pages and more pages are continuously added in Part D. All in a highly organized manner that avoids the chaos of an Internet site (due to the unavoidably invisible structure of the site) and the "black box" behavior of a mathematical software (which gives only the result but not the method of derivation).

There are some very good **sites on the Internet** with much more information, where the visitor can spend as much time as he wants, even for a dissertation. But searching takes time, the most valuable commodity of all. Also, there are some remarkable packages of **mathematical software**, which can do numerical or algebraic calculations very fast and give us the results. The **Mathematical Handbook** does not replace them or eliminate their usefulness. These three entities are **supplementary** to each other, not substitutes. Information in digital form will never replace the printed form, because the disadvantage of a printed book (i.e. it cannot be changed after printing) is also an advantage (since it constitutes a solid base where we can find information at the same page always). It is up to the user to know which source of information is the best in each case.

Why I should not buy this Mathematical Handbook!

A list of assignments follows. All these assignments (and hundreds similar to them from elementary to advanced mathematics) can be answered very fast using this handbook. The reader is challenged to answer them using only a site or a mathematical software or both. If he can answer them faster than using this handbook (all in less than an 90 min), then he is exceptional, he does not need this handbook and **he should not buy it**!

A test of usefulness

To grasp the usefulness of this **Mathematical Handbook** try to carry out the following assignments using Internet and mathematical software. You will see that in each case the time needed to complete the assignment is much more than the time you need with this handbook (the page with the answer and an estimation of the time needed are given in a parenthesis). Furthermore, to reach the answer may require a lot of calculations by hand. Do not be surprised if in some cases you cannot reach a complete answer.

1) Write $x^4 + y^4$ and then $x^{2n} + y^{2n}$ ($n = 2, 4, \dots$) as a product of real polynomials. (p. 6, 1 min)

2) Draw the trigonometric circle and use it to justify the relations of trigonometric numbers for x and $-x$, x and $\pi/2 - x$, x and $x + \pi$. (p. 21, 23, 2 min)

3) Give an exact numerical expression (with integers and roots of integers) of $\sin x$, $\cos x$, $\tan x$, where $x = 9°$. (p. 22, Ad0221, 4 min)

4) A plane triangle has sides a, b, c. Express its height, median and inner bisector, which correspond to side a. Also, its area and the radii of inscribed and circumscribed circles. (p. 29, 3 min)

5) In the xy-plane an ellipse has its major axis on the x-axis. Give its equation in polar coordinates (r, θ) if the origin of the coordinate system is (a) at the left focus, (b) at the right focus. (p. 41, 3 min)

6) Write the derivatives of 10 (or 20) elementary functions a student has to remember in order to be able to derive derivatives of more complicated functions. (p. 58-60, 4 min)

7) Let $f(x)$ be a function which has derivatives of any order in an open interval (a, b). Write the conditions which $f(x)$ has to satisfy at $x = x_0$ $(a < x_0 < b)$ in order to have a maximum at $x = x_0$. (p.62, 2 min)

8) Write the indefinite integrals of 10 (or 20) elementary functions a student has to remember in order to be able to derive integrals of more complicated functions. (p. 66-67, 5 min)

9) Find expressions for the indefinite integral of $(ax^2 + bx + c)^{-1/2}$, covering all cases $a > 0$, $a < 0$, $b^2 - 4ac > 0$, $b^2 - 4ac < 0$. (p. 88, 3 min)

10) Find the indefinite integral of $(\sin 2nx)/(\sin x)$, where n is a positive integer. (p.96, 2 min)

11) Find the indefinite integral of $x^n \cos x$, where n is a positive integer. (p. 101, 2 min)

12) Find the definite integral of $[f(ax) - f(bx)]/x$ from 0 to ∞ if $f(x) \to 1$ as $x \to 0+$. (p. 128, Ad1282, 5 min)

13) Find the sum $\cos x + \cos 3x + \cos 5x + \cdots + \cos(2n - 1)x$. (p. 157, 2 min)

14) Prove the Gibbs phenomenon for a Fourier series. (p.168, Ad1681, 5 min)

15) Express the directional derivative of a scalar field Φ along a vector $\mathbf{A}$ in orthogonal curvilinear coordinates in three dimensional Euclidean space. Also, in spherical coordinates. (p. 190-191, 2 min)

16) Write five (or ten) integrals (indefinite or definite) containing a Bessel function in the integrand. p. 206, 3 min)

17) Write $\sin x$ and $\cos x$ as infinite sums of Bessel functions. (p. 210, 2 min)

18) Write the Legendre polynomials $P_n(\cos\theta)$ for $n = 2, 3, 4, 5$, as linear combinations of $\cos k\theta$ (k integer). (p. 212, 2 min)

19) Give the formulas for expanding a function $f(x)$ in series of Hermite and Chebyshev polynomials. (p. 225, 231, 3 min)

20) Give at least three cases where a hypergeometric function with special arguments reduces to elementary trigonometric functions. (p. 241, 3 min)

21) Give asymptotic expressions (for large x) of sine and cosine integrals. (p. 246, 2 min)

22) Find a function $f(t)$ for which the Fourier transform is $f(\omega)$. (p. 252, 3 min)

23) Find the Fourier transforms of e^{-kr} $(k > 0)$ and r^{-a} $(1 < a < 3)$, where $r = (x^2 + y^2 + z^2)^{1/2}$. (p.264, 2 min)

24) Write the Laplace transform of $f(t)\sin\omega t$ if the Laplace transform of $f(t)$ is $F(s)$. (p. 266, 2 min)

25) Describe briefly the method of numerical integration based on the Gauss-Legendre formulas by giving the formulas for the coefficients and the first zeros of $P_n(x)$ for $n \leq 4$. (p. 288, Ad2882, 5 min)

26) Give the formulas and describe briefly a predictor-corrector method for solving an ODE. (p. 290, Ad2901, 5 min)

27) Give the formulas and describe briefly a method for solving a boundary value problem for the Laplace PDE. (p. 291, 4 min)

28) Give the names and the basic formulas of five probability distributions, which are symmetric with respect to their mean values. (p. 297-301, 4 min)

29) Give the two-sided $r\%$ confidence interval for the variance σ^2 of a normal population in terms of the sample variance s^2. (p. 305, 2 min)

30) Give the region of acceptance at significance level α for a two-sided test of a hypothesis H_0: $\mu_1 = \mu_2$ of two normal populations with mean values μ_1, μ_2 and variances σ_1, σ_2. (p. 307, 2 min)