普通高等教育“十五”规划教材
PUTONG GAODENG JIAOYU SHIWU GUIHUA JIAOCAI

自动化专业英语

王建国 陈东淼 主编

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内 容 提 要

本书是普通高等教育“十五”规划教材，是针对自动化专业的特点进行编写的。全书共分四部分，主要包括公共基础理论部分（高等数学、线性代数、积分变换等），专业基础部分（电路、模拟电子、数字电子、电力电子等），专业部分（微型计算机、网络、自动控制、检测技术及仪表等），新兴技术部分（微传感技术、人工智能、专家系统、机器人等）等内容。每个单元包含正文、专业词汇、常用词组、难点注释和专题练习等五个部分。每章结合单元内容提供专业英语阅读技巧、翻译技巧、专业词汇构词技巧、写作技巧等知识性内容，并配有有一定有难度的阅读材料。考虑学生的开课学期、先修课程和计划学时等情况，合理安排单元内容，以符合教学要求。

本书主要作为自动化专业的教材，也可作为函授和自考辅导用书或供相关专业人员参考。

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序

由中国电力教育协会组织的普通高等教育“十五”规划教材，经过各方的努力与协作，现在陆续出版发行了。这些教材既是有关高等院校教学改革成果的体现，也是各位专家教授丰富的教学经验的结晶。这些教材的出版，必将对培养和造就我国21世纪高级专门人才发挥十分重要的作用。

自1978年以来，原水利电力部、原能源部、原电力工业部相继规划了一至四轮统编教材，共计出版了各类教材1000余种。这些教材在改革开放以来的社会主义经济建设中，为深化教育教学改革，全面推进素质教育，为培养一批批优秀的专业人才，提供了重要保证。原全国高等学校电力、热动、水电类专业教学指导委员会在此间的教材建设工作中，发挥了极其重要的历史性作用。

特别需要指出的是，“九五”期间出版的很多高等学校教材，经过多年的教学实践检验，现在已经成为广泛使用的精品教材。这批教材的出版，对于高等教育教材建设起到了很好的指导和推动作用。同时，我们也应该看到，现用教材中有不少内容陈旧，未能反映当前科技发展的最新成果，不能满足按新的专业目录修订的教学计划和课程设置的需要，而且一些课程的教材可供选择的品种太少。此外，随着电力体制的改革和电力工业的快速发展，对于高级专门人才的需求格局和素质要求也发生了很大变化，新的学科门类也在不断发展。所有这些，都要求我们的高等教育教材建设必须与时俱进，开拓创新，要求我们尽快出版一批内容新、体系新、方法新、手段新，在内容质量上、出版质量上有突破的高水平教材。

根据教育部《关于“十五”期间普通高等教育教材建设与改革的意见》的精神，“十五”期间普通高等教育教材建设的工作任务就是通过多层次的教材建设，逐步建立起多学科、多类型、多层次、多品种系列配套的教材体系。为此，中国电力教育协会在充分发挥各有关高校学科优势的基础上，组织制订了反映电力行业特点的“十五”教材规划。“十五”规划教材包括修订教材和新编教材。对于原能源部、电力工业部组织原全国高等学校电力、热动、水电类专业教学指导委员会编写出版的第一至四轮全国统编教材、“九五”国家重点教材和其他已出版的各类教材，根据教学需要进行修订。对于新编教材，要求体现电力及相关行业发展对人才素质的要求，反映相关专业科技发展的最新成就和教学内容、课程体系的改革成果，在教材内容和编写体系的选择上不仅要有本学科（专业）的特色，而且注意体现素质教育和创新能力与实践能力的培养，为学生知识、能力、素质协调发展创造条件。考虑到各校办学特色和培养目标不同，同一门课程可以有多本教材供选择使用。上述教材经中国电力教育协会电气工程学科教学委员会、能源动力工程学科教学委员会、电力经济管理学科教学委员会的有关专家评审，推荐作为高等学校教材。

在“十五”教材规划的组织实施过程中，得到了教育部、国家经贸委、国家电力公司、中国电力企业联合会、有关高等院校和广大教师的大力支持，在此一并表示衷心的感谢。

教材建设是一项长期而艰巨的任务，不可能一蹴而就，需要不断完善。因此，在教材的使用过程中，请大家随时提出宝贵的意见和建议，以便今后修订或增补。（联系方式：100761 北京市宣武区白广路二条1号综合楼9层　中国电力教育协会教材建设办公室 010—63416237）

中国电力教育协会

二〇〇二年八月

前 言

自动化水平是衡量一个国家发达程度的重要标志，开发和应用自动化技术是现代工业生存和发展的必然趋势。自动化学科与高新技术紧密相关，专业内容新颖丰富，知识更新周期较短，该学科是我国科技发展战略中的重要学科之一。在经济全球化的今天，我国迫切需要大批专业技术精、英语能力强的应用型自动化人才，迫切需要用自动化技术来提升比例巨大而又相对落后的传统产业，迫切需要研发具有自主知识产权的高精尖产品，因此对高等教育阶段的专业英语课程提出了新的、更高的要求。

自动化专业的性质决定了该学科的毕业生具有较强的工作适应性，可从事的技术领域涉及电工、电子技术、计算机及其应用、计量测试仪器、检测控制仪表等与之相关的各个领域。因此，我们在编写过程中内容选材着重考虑以下四个方面：

1. 公共基础理论部分（高等数学、线性代数、积分变换等）；
2. 专业基础部分（电路、模拟电子、数字电子、电力电子等）；
3. 专业部分（微型计算机、网络、自动控制、检测技术及仪表等）；
4. 新兴技术部分（微机械、虚拟传感技术、人工智能与专家系统、机器人技术等）。

内容原型均取材于以英语为母语学者撰著的文献或著作，适当编辑修改，力求简洁、实用、语言地道、词汇典型且规范。有一定专业难度同时专业词汇有一定的复现性。专业内容力求强化技术应用，弱化理论推导；内容覆盖面宽，力求反映新技术、新产品和新概念，力争建立自动化英语的整体概念。

全书分四大部分，共计十二章四十一个单元。每个单元含正文、专业词汇及常用词组、难点注释和专题练习四个部分。每章最后结合单元内容提供专业英语阅读技巧、翻译技巧、专业词汇构词技巧等知识性内容并附加一定数量的阅读材料。单元内容在安排上考虑了学生的开课学期、先修课程和计划学时情况，教学过程中，教师可根据实际需要对教材内容进行合理取舍或调整次序，使教学过程合理、顺畅。

本书由东北电力大学王建国和陈东淼主编，陈伟、彭雅轩老师及在校硕士生付宏伟为本书的文字录入、图表整理及内容校对作出了大量工作。华北电力大学柳亦兵教授担任本书的主审，并提出许多宝贵意见。限于编者水平，书中疏漏和不当之处，请读者不吝指教，以利修订。

编 者

2005 年 5 月

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Part III Major Courses of Automation Specialty

Part IV Automation New Technology

Part I General Basic Knowledge

Chapter 1 Calculus

1.1 Derivative

The derivative of a function is the first of the two major concepts of calculus. Together with the integral, it constitutes the source from which calculus derives its particular flavor. The concept will be introduced with the intimate connection between the mathematical concepts and certain physical ideas. In fact, the demands of physics were the original inspiration for these fundamental ideas of calculus. So, we shall first define the ideas in precise mathematical form, and discuss their significance in terms of mathematical problems, then mention the physical interpretations.

To understand the derivative, we can start from the tangent line of a curve. As the illustration in the Figure 1.1, the definition of a tangent line might start with "secant lines," and use the notion of limits. If $h \neq 0$, then the two distinct points $(a, f(a))$ and $(a + h, f(a + h))$ determine, a straight line whose slope is $\frac{f(a+h) - f(a)}{h}$.

The "tangent line" at $(a, f(a))$ seems to be the limit, in some sense, of these "secant lines" as h approaches 0. And the limit of the slope of the tangent line through $(a, f(a))$ should be $\lim\limits_{h \to 0} \frac{f(a+h) - f(a)}{h}$.

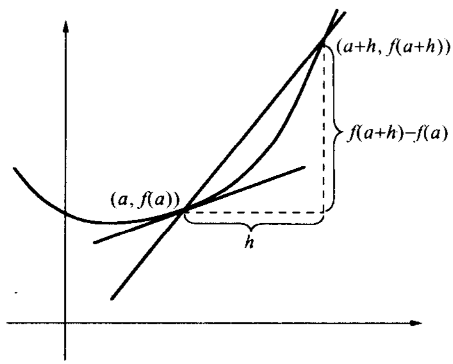

Figure 1.1 The tangent line of a curve

Now we can give the ***definition***,

The function f is ***differentiable*** at a if $\lim\limits_{h \to 0} \frac{f(a+h) - f(a)}{h}$ exists.

And the limit is denoted by $f'(a)$ and is called the ***derivative*** of f at a. Or we can say that function f is differentiable only if f is differentiable at a for every a in the domain of f.

As an addendum, we define:

The ***tangent line*** to the graph of function f at $(a, f(a))$ is the line through $(a, f(a))$

with slope $f'(a)$. This means that the tangent line at $(a, f(a))$ is existed only if function f is differentiable at a.

Concerning the notation of the derivative of function f, the symbol $f'(a)$ is a certainly reminiscent. Moreover, for the derivative of any function f, we denote by f' that the function whose domain is the set of all numbers a is differentiable at a, and whose value at such a number a is $\lim\limits_{h \to 0} \frac{f(a+h)-f(a)}{h}$.

Refers to the physical interpretation of the derivative, let's consider a particle which is moving along a straight line (Figure 1.2) on which we have chosen an "origin" point O, and a direction in which distances from O shall be written as positive numbers, the distance from O of points in the other direction being written as negative numbers.

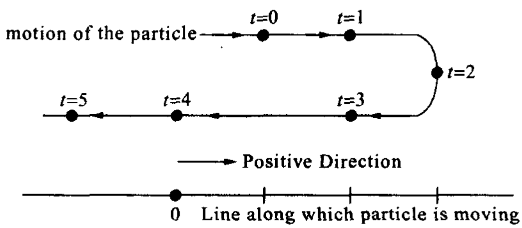

Figure 1.2 A particle moving along a straight line

Let $s(t)$ denote the distance of the particle from O, at time t. Since a distance $s(t)$ is determined for each number t, the physical situation automatically supplies us with a certain function s.

The graph of $s(t)$ indicates the distance of the particle from O, on the vertical axis, in terms of the time, indicated on the horizontal axis (Figure 1.3).

The quotient $\frac{s(t_0+\Delta t)-s(t_0)}{\Delta t}$ has a natural physical interpretation. It is the "average velocity" of the particle during the time interval from t_0 to $t_0+\Delta t$. For any particular t_0, this average speed depends on Δt. On the other hand, the limit $\lim\limits_{\Delta t \to 0} \frac{s(t_0+\Delta t)-s(t_0)}{\Delta t}$ depends only on t_0 as well as the particular function $s(t)$.

Conventionally, we would like to speak of the "velocity of the particle at time t_0," but the usual definition of velocity is really a definition of average velocity; the only reasonable definition of "velocity at time t_0" (so-called "instantaneous velocity") is the limit $\lim\limits_{\Delta t \to 0} \frac{s(t_0+\Delta t)-s(t_0)}{\Delta t}$.

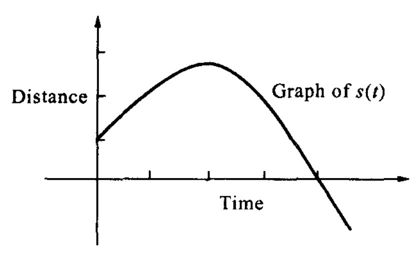

Figure 1.3 The graph of $s(t)$

Therefore, we define the (instantaneous) ***velocity*** of the particle at t_0 to be $s'(t_0)$ – the ***derivative*** of $s(t)$ at t_0. And the absolute value

$|s'(t_0)|$ is sometimes called the (instantaneous) ***speed***.

The velocity of a particle is often called the "rate of change of its position." This notion of the derivative, as a rate of change, could apply to any other physical situation in which some quantity varies with time. For example, the "rate of change of mass" of a growing object, $m'(t)$, means the derivative of the function m, where $m(t)$ is the mass at time t.

New Words and Expressions

- derivative [di'rivətiv] n. 导数，微商，派生的事物，派生词；adj.引出的，系出的
- calculus ['kælkjuləs] n. 微积分学，运[演]算
- integral ['intigrəl] adj.完整的，整体的，积分的，构成整体所需要的；n. 积分，完整，部分
- inspiration [ˌinspə'reiʃən] n.灵感
- interpretation [inˌtə:pri'teiʃən] n.解释，阐明，口译，通译
- tangent ['tændʒənt] n.切线，正切；adj. 接触的，切线的，相切的，离题的
- secant ['si:kənt] adj.切的，割的，交叉的；n.割线，正切
- addendum [ə'dendəm] n. 补遗，附录
- vertical ['və:tikəl] adj.垂直的，直立的，顶点的；n.垂直线，垂直面，竖向
- horizontal axis 水平轴(线)
- quotient ['kwəuʃənt] n.商，份额
- instantaneous [ˌinstən'teinjəs] adj.瞬间的，即刻的，即时的

Notes

- The concept will be introduced with the intimate connection between the mathematical concepts and certain physical ideas. 本概念将会通过数学概念与之特定的物理含义之间的紧密联系加以介绍。
- The tangent line of a curve. 曲线的切线。
- Moreover, for the derivative of any function f, we denote by f' that the function whose domain is the set of all numbers a is differentiable at a, and whose value at such a number a is $\lim\limits_{h\to 0}\dfrac{f(a+h)-f(a)}{h}$. 句中 the set of all numbers a,指所有数字 a 的集合。
- "origin" point O. (坐标的)原点 O。
- The graph of $s(t)$ indicates the distance of the particle from O, on the vertical axis, in terms of the time, indicated on the horizontal axis. 图型 $s(t)$中,纵轴代表颗粒距原点的距离,横轴代表时间。
- The velocity of a particle is often called the "rate of change of its position." 颗粒的速度

通常被称为“位置变化率”。

Questions for Discussion

- How do you define the derivative of f at a in precise mathematical form?
- Why is the velocity of a particle called the rate of change of its position?
- What is the intimate connection between the mathematical concepts and certain physical ideas for the derivative in the text.
- What is the meaning of $\lim\limits_{h\to 0}\frac{f(a+h)-f(a)}{h}$?
- Give the definition of average velocity of a particle according to the text.

Match the following words in column A with the statements in column B

A	B
☐ particle	a. A variable so related to another that for each value assumed by one there is a value determined for the other.
☐ derivative	b. A method of analysis or calculation using a special symbolic notation
☐ interpretation	c. Stimulation of the mind or emotions to a high level of feeling or activity
☐ intimate	d. Occurring or completed without perceptible delay
☐ secant	e. Something added
☐ addendum	f. A straight line intersecting a curve at two or more points.
☐ instantaneous	g. To make known subtly and indirectly
☐ inspiration	h. An explanation
☐ calculus	i. The limiting value of the ratio of the change in a function to the corresponding change in its independent variable
☐ function	j. A very small piece or part; a tiny portion or speck

Translate the following sentences into Chinese

- Conventionally, we would like to speak of the "velocity of the particle at time t_0," but the usual definition of velocity is really a definition of average velocity; the only reasonable definition of "velocity at time t_0" (so-called "instantaneous velocity") is the limit $\lim\limits_{\Delta t\to 0}\frac{s(t_0+\Delta t)-s(t_0)}{\Delta t}$.
- The velocity of a particle is often called the "rate of change of its position." This notion

of the derivative, as a rate of change, could apply to any other physical situation in which some quantity varies with time. For example, the "rate of change of mass" of a growing object, $m'(t)$, means the derivative of the function m, where $m(t)$ is the mass at time t.

1.2 Integral

The concept of integral is more complicated than the concept of derivative. To understand integrals, we does need make a long preparation, but once this preliminary work has been completed, integrals and its significance will be understood straightforward. Although ultimately to be defined in a quite complicated way, the integral could start with formalizing a simple, intuitive concept-that of area. By now it should come as no surprise to learn that the definition of an intuitive concept can present great difficulties-"area" is certainly no exception.

Basically, we try to define the area of some very special regions (Figure 1.4)-those that are bounded by the horizontal axis, the vertical lines through $(a, 0)$ and $(b, 0)$, and the graph of a function f such that $f(x) \geqslant 0$ for all x in $[a, b]$.

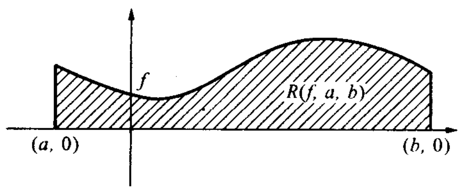

Figure 1.4 The area of some very special regions

It is convenient to denote this region by $R(f, a, b)$. In these regions, they include rectangles and triangles, as well as many other important geometric figures. The value that we will eventually assign as the area of $R(f, a, b)$ will be called the ***integral*** of function f on $[a, b]$.

The idea behind the prospective definition is indicated in Figure 1.5. The interval $[a, b]$ has been divided into finite subintervals $[t_0, t_1]$ $[t_1, t_2]$ $[t_2, t_3] \cdots [t_{n-1}, t_n]$, by means of numbers $t_0, t_1, t_2, \cdots, t_n$ with $a = t_0 < t_1 < t_2 < \cdots < t_n = b$.

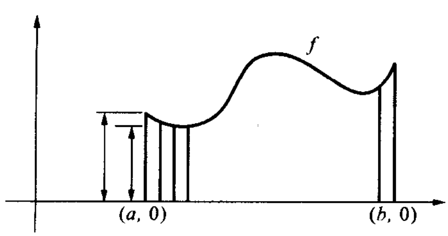

Figure 1.5 The idea behind the prospective definition

On the first interval $[t_0, t_1]$ the function f has the minimum value m_1 and the maximum value M_1; similarly, on the ith interval $[t_{i-1}, t_i]$ let the minimum value of f be m_i and let the maximum value be M_i. The sum $s = m_1(t_1 - t_0) + m_2(t_2 - t_1) + m_3(t_3$

$- t_2) + \cdots + m_n(t_n - t_{n-1})$ represents the total area of rectangles lying inside the region $R(f, a, b)$, while the sum $S = M_1(t_1 - t_0) + M_2(t_2 - t_1) + M_3(t_3 - t_2) + \cdots + M_n(t_n - t_{n-1})$ represents the total area of rectangles containing the region $R(f, a, b)$. The guiding principle of our attempt to define the area A of $R(f, a, b)$ is the observation that A should satisfy $s \leqslant A$ and $A \leqslant S$, and that this should be true, no matter how the interval $[a, b]$ is subdivided.

DEFINITION:

Suppose f is bounded on $[a, b]$ and $P = \{t_0, \cdots, t_n\}$ is a partition of $[a, b]$. Let

$$m_i = \inf \{f(x): t_{i-1} \leqslant x \leqslant t_i\},$$
$$M_i = \sup \{f(x): t_{i-1} \leqslant x \leqslant t_i\}.$$

The lower sum of f for P, denoted by $L(f, P)$, is defined as

$$L(f,P) = \sum_{i=1}^{n} m_i(t_i - t_{i-1})$$

The upper sum of f for P denoted by $U(f, P)$, is defined as

$$U(f,P) = \sum_{i=1}^{n} M_i(t_i - t_{i-1})$$

However, that despite the geometric motivation, these sums have been defined precisely without any appeal to a concept of "area."

Two details of the definition deserve comment. The requirement that f be bounded on $[a, b]$ is essential in order that all the m_i and M_i be defined. Also, that it was necessary to define the numbers m_i and M_i as *inf's* and *sup*'s, rather than as minima and maxima, since f was not assumed continuous.

One thing is clear about lower and upper sums: If P is any partition, then obviously $L(f,P) \leqslant U(f,P)$, and for each i we have $m_i(t_i - t_{i-1}) \leqslant M_i(t_i - t_{i-1})$.

On the other hand, something less obvious ought to be true: If P_1 and P_2 are any two partitions of $[a, b]$, then it should be the case that $L(f,P_1) \leqslant U(f,P_2)$, because $L(f, P_1)$ should be $\leqslant$ area $R(f, a, b)$, and $U(f, P_2)$ should be $\geqslant$ area $R(f, a, b)$. To proof this case, we are about to give depends upon a lemma, which concerns the behavior of lower and upper sums when more points are included in a partition.

LEMMA:

If Q contains P (i.e., if all points of P are also in Q), then

$$L(f, P) \leqslant L(f, Q)$$
$$U(f, P) \geqslant U(f, Q)$$

The partition Q can be obtained from P by adding one point at a time; in other words, there is a sequence of partitions $P = P_1, P_2, \cdots, P_a = Q$ such that P_{j+1} contains just one more point than P_j. Then

$$L(f, P) = L(f, P_1) \leqslant L(f, P_2) \leqslant \cdots \leqslant L(f, P_a) = L(f, Q)$$

and

$$U(f, P) = U(f, P_1) \geqslant U(f, P_2) \geqslant \cdots \geqslant U(f, P_a) = U(f, Q)$$

Based on this lemma, we can prove the consequence of that case simply.

There is a partition P that contains both P_1 and P_2 (let P consist of all points in both P_1 and P_2). According to the lemma,

$$L(f, P_1) \leqslant L(f, P) \leqslant U(f, P) \leqslant U(f, P_2)$$

Therefore, that any upper sum $U(f, P')$ is an upper bound for the set of all lower sums $L(f, P)$. That means any upper sum $U(f, P')$ is greater than or equal to the least upper bound of all lower sums: *sup* $\{L(f, P): P \text{ a partition of } [a, b]\} \leqslant U(f, P')$, for every P'.

It may well happen that sup $\{L(f, P)\}$ = inf $\{U(f, P)\}$; in this case, this is the only number between the lower sum and upper sum of f for all partitions, and this number is consequently an ideal candidate for the area of $R(f, a, b)$.

On the other hand, if sup $\{L(f, P)\}$ < inf $\{U(f, P)\}$, then every number x between sup $\{L(f, P)\}$ and inf $\{U(f, P)\}$ will satisfy $L(f, P') \leqslant x \leqslant U(f, P')$ for all partitions P'.

DEFINITION:

A function f which is bounded on $[a, b]$ is integrable on $[a, b]$ if sup $\{L(f, P): P$ a partition of $[a, b]\}$ = inf $\{U(f, P): P$ a partition of $[a, b]\}$. In this case, this common number is called the integral of f on $[a, b]$ and is denoted by $\int_a^b f(x)$.

(The symbol $\int_a^b f(x)$ is called an integral sign and was originally an elongated s, for "sum;" the numbers a and b are called the lower and upper limits of integration.) The integral $\int_a^b f(x)$ is also called the area of $R(f, a, b)$ when $f(x) \geqslant 0$ for all x in $[a, b]$.

If f is integrable, then according to this definition, $L(f, P) \leqslant \int_a^b f(x) \leqslant U(f, P)$ for all partitions P of $[a, b]$. Moreover, $\int_a^b f(x)$ is the unique number with this property.

New Words and Expressions

- preliminary [pri'liminəri] adj.预备的，初步的

- straightforward [streit'fɔ:wəd] adj. 简单的，直接了当的；adv. 坦率地，直接了当地
- intuitive[in'tju(:)itiv] adj.直观的，直觉的
- rectangle ['rektæŋgl] n.长方形，矩形
- triangle ['traiæŋgl] n.三角形，三人一组，三角关系
- geometric [dʒiə'metrik] adj.几何的，几何学的
- requirement[ri'kwaiəmənt] n.必要条件，需求，要求，需要的东西，要求必备的条件
- assign [ə'sain] vt.分配，指派；v. 赋值
- prospective[prəs'pektiv] adj.预期的，未来的
- subinterval ['sʌb'intəvəl] n.子区间
- subdivide ['sʌbdi'vaid] v.再分，细分
- deserve [di'zə:v] vt.应受，值得；v.应受
- lemma ['lemə] n.引理，辅助定理，论点，主旨，(文章论点的)标题，(词典的)词条
- consequence ['kɔnsikwəns] n.结果，[逻]推理，推论，因果关系，重要的地位
- elongate ['i:lɔŋgeit] v.拉长，(使)伸长，延长；adj.伸长的；n.拉长，伸长

Notes

- By now it should come as no surprise to learn that the definition of an intuitive concept can present great difficulties-"area" is certainly no exception.至此，人们会很自然地知道(不再惊讶于)用一个直观概念可以表达出非常困难的定义—当然"面积"也不例外。
- The value that we will eventually assign as the area of $R(f, a, b)$ will be called the ***integral*** of function f on $[a, b]$.作为 $R(f, a, b)$的面积，我们最终要赋予的值将被称为函数 f 在$[a, b]$上的积分。
- However, that despite the geometric motivation, these sums have been defined precisely without any appeal to a concept of "area."然而，无论几何含义的动机如何，这些总和没有用到任何面积的概念就已经得到了精确的定义。

Questions for Discussion

- How can we understand the concept of integral and its significance with area?
- What is the meaning of the symbol $\int_a^b f(x)$?