普通高等教育“十一五”国家级规划教材

SCIENTIFIC ENGLISH ON
COMMUNICATIONS AND
ELECTRONIC INFORMATION

张敏瑞　张　红◎编著

通信与电子信息科技英语

（修订版）

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内容简介

本书是为高等院校通信与电子信息类专业学生编写的专业英语教材。课文和阅读材料的内容均选自国外经典英文原著、国外高等院校的教科书以及国际著名期刊与杂志等。全书按照通信与信息处理基础、传输技术、信号处理、传输系统、交换技术、Internet与信息安全这一主线展开，涵盖了通信与电子信息类专业本科生课程的绝大部分内容。

本书共分18个单元，每单元包含课文、难句注释、练习、阅读材料以及词汇与练习；每篇课文后都配有标注音标的生词表、短语及专业术语表；全书还安排了非常实用的5篇补充学习材料。

本书可作为高等院校通信工程、电子科学与技术、电子信息工程、电子信息科学与技术等专业的本科生"专业英语"课程教材，也可用作相关专业研究生专业英语课外阅读，还可供相关专业的工程技术人员学习和参考。

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修订版前言

本书自2003年12月首次出版后，得到了广大师生的厚爱，平均每年重印一次。但是，为了更好地满足广大读者的需求，使其更方便地进行科技英语的教学，作者认为有必要对原书进行适当调整和修改。本次修订的主要内容如下。

1. 课文内容：去掉了ATM、网络管理、无线网络安全等内容，增加了有关通信设备，交换技术、信息安全的内容。从技术的角度讲，内容更新了，视野更广了。

2. 补充学习材料：增加了“关于数的英文读法”和“常见数学表达式的读法”两篇；大幅修改了“科技论文英文摘要写作”。新增的两篇学习材料主要解决科技学术交流中的实际困难，这是本次修订的一大亮点。

3. 词汇方面：对绝大部分原有单元的生词、短语和部分注释进行了调整和修改。删去了生词和短语表中重复的词汇，所以建议最好按顺序学习。但考虑到没有时间学习“Reading”的情况，“Reading”中出现的词汇仍保留在后续课文的词汇表中。

4. 新增附录：在本书最后增加了“词汇索引”，包括书中“TEXT”和“Reading”中列出的所有生词和短语，并按字母顺序排序，便于广大师生在备课和复习时查阅。

5. 格式方面：课文标题、字母大小写等格式按英文习惯进行了统一调整。

五年来，作者收到了许多师生索要教学课件和课文译文的电子邮件。首先作者对这些热心读者和其他所有关心和支持本书的读者表示感谢！需要说明两点：第一，原书的教学课件在北京邮电大学出版社，修订版的教学课件也将于2009年9月前提交，需要者可向出版社索要；第二，我们没有做详细的课文译文，因为多年的教学经验告诉我们，详细译文会使部分学生失去听课兴趣，从而大大影响教学质量。但是，为了方便部分年轻教师备课，我们正在考虑编写本书的教辅和其他相关材料。

感谢美国University of Illinois at Urbana-Champaign(UIUC)English as a second language的开拓者和老专家Susan Taylor女士，她对本书的部分内容进行了审阅和修改。感谢武汉理工大学外语学院英语教师杜玲莉副教授对本书部分内容的建议。感谢西安空间无线电技术研究所博士生导师周诠研究员，他

帮助解答了部分专业方面的问题并对本书部分内容进行了审阅和修改。感谢西安科技大学硕士张杨梅、罗人木、任鹏宽，硕士生沈丽萍、吴道龙等，他们在修订版的文字编辑和课件制作等方面付出了艰苦的劳动。感谢北京邮电大学出版社各位同仁为本书的顺利出版所做的工作。

另外，本书受到了下列项目的资助和支持，在此一并表示衷心的感谢！(1)国家教育部“普通高等教育‘十一五’国家级教材规划”项目；(2)“十一五”国家课题“我国高校应用型人才培养模式研究”重点子项目(FIB070335-A7-07)；(3)西安科技大学校级重点教改项目(JG08003)；(4)西安科技大学校级重点教改项目(JG08008)。

由于作者水平有限，书中难免出现不足之处，敬请读者、广大教师和学生批评指正。

作　者

于西安科技大学和美国 UIUC

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CONTENT

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UNIT 1

TEXT

RANDOM PROCESSES

To determine the probabilities of the various possible outcomes of an experiment, it is necessary to repeat the experiment many times. Suppose then that we are interested in establishing the statistics associated with the tossing of a die. We might proceed in either of two ways. On one hand, we might use a single die and toss it repeatedly. Alternatively, we might toss simultaneously a very large number of dice. Intuitively, we would expect that both methods would give the same results. Thus, we would expect that a single die would yield a particular outcome, on the average, of 1 time out of 6. Similarly, with many dice we would expect that 1/6 of the dice tossed would yield a particular outcome[1].

Analogously, let us consider a random process such as a noise waveform $n(t)$. To determine the statistics of the noise, we might make repeated measurements of the noise voltage output of a single noise source, or we might, at least conceptually, make simultaneous measurements of the output of a very large collection of statistically identical noise sources. Such a collection of sources is called an ensemble, and the individual noise waveforms are called sample functions. A statistical average may be determined from measurements made at some fixed time $t=t_1$ on all the sample functions of the ensemble. Thus to determine, say, $\overline{n^2(t)}$, we would, at $t=t_1$, measure the voltages $n(t_1)$ of each noise source, square and add the voltages, and divide by the (large) number of sources in the ensemble. The average so determined is the ensemble average of $n^2(t_1)$.

Now $n(t_1)$ is a random variable and will have associated with it a probability density function. The ensemble averages will be identical with the statistical averages and may be represented by the same symbols. Thus the statistical or ensemble average of $n^2(t_1)$ may be written $E[n^2(t_1)] = \overline{n^2(t_1)}$. The averages determined by measurements on a single sample function at successive times will yield a time average, which we represent as $\langle n^2(t) \rangle$.

In general, ensemble averages and time averages are not the same.

Suppose, for example, that the statistical characteristics of the sample functions in the ensemble were changing with time. Such a variation could not be reflected in measurements made at a fixed time, and the ensemble averages would be different at different times. When the statistical characteristics of the sample functions do not change with time, the random process is described as being stationary. However, even the property of being stationary does not ensure that ensemble and time averages are the same. For it may happen that while each sample function is stationary the individual sample functions may differ statistically from one another. In this case, the time average will depend on the particular sample function which is used to form the average. When the nature of a random process is such that ensemble and time averages are identical, the process is referred to as ergodic. An ergodic process is stationary, but, of course, a stationary process is not necessarily ergodic.

Throughout this text we shall assume that the random processes with which we shall have occasion to deal are ergodic[2]. Hence the ensemble average $E\{n(t)\}$ is the same as the time average $\langle n(t)\rangle$, the ensemble average $E\{n^2(t)\}$ is the same as the time average $\langle n^2(t)\rangle$, etc.

Autocorrelation

A random process $n(t)$, being neither periodic nor of finite energy has an autocorrelation function

$$R(\tau) = \lim_{T\to\infty} \frac{1}{T}\int_{-T/2}^{T/2} n(t)n(t+\tau)\mathrm{d}t \tag{1.1}$$

In connection with deterministic waveforms we were able to give a physical significance to the concept of a power spectral density $G(f)$ and to show that $G(f)$ and $R(\tau)$ constitute a Fourier transform pair. As an extension of that result we shall define the power spectral density of a random process in the same way. Thus for a random process we take $G(f)$ to be

$$G(f) = \int_{-\infty}^{+\infty} R(\tau)\mathrm{e}^{-\mathrm{j}\omega\tau}\mathrm{d}\tau \tag{1.2}$$

It is of interest to inquire whether $G(f)$ defined in Eq. (1.2) for a random process has a physical significance which corresponds to the physical significance of $G(f)$ for deterministic waveforms.

For this purpose consider a deterministic waveform $v(t)$ which extends from $-\infty$ to $+\infty$. Let us select a section of this waveform which extends from $-T/2$ to $T/2$. This waveform $v_T(t) = v(t)$ in this range, and otherwise $v_T(t) = 0$. The waveform $v_T(t)$ has a Fourier transform $V_T(f)$. We recall that $|V_T(f)|^2$ is the energy spectral density; that is, $|V_T(f)|^2 \mathrm{d}f$ is the normalized energy in the spectral range $\mathrm{d}f$. Hence, over the interval T the normalized power density is $|V_T(f)|^2/T$. As $T \to \infty$, $v_T(t) \to v(t)$, and we then have the result that the physical significance of the power spectral density $G(f)$, at least for a deterministic waveform, is that

$$G(f) = \lim_{T \to \infty} \frac{1}{T} |V_T(f)|^2 \tag{1.3}$$

Correspondingly, we state, without proof, that when $G(f)$ is defined for a random process, as in Eq. (1.2), as the transform of $R(\tau)$, then $G(f)$ has the significance that

$$G(f) = \lim_{T \to \infty} E\left\{\frac{1}{T} |N_T(f)|^2\right\} \tag{1.4}$$

where $E\{\ \}$ represents the ensemble average or expectation and $N_T(f)$ represents the Fourier transform of a truncated section of a sample function of the random process $n(t)$.

The autocorrelation function $R(\tau)$ is, as indicated in Eq. (1.1), a time average of the product $n(t)$ and $n(t+\tau)$. Since we have assumed an ergodic process, we are at liberty to perform the averaging over any sample function of the ensemble, since every sample function will yield the same result. However, again because the noise process is ergodic, we may replace the time average by an ensemble average and write, instead of Eq. (1.1),

$$R(\tau) = E\{n(t)n(t+\tau)\} \tag{1.5}$$

The averaging indicated in Eq. (1.5) has the following significance: At some fixed time t, $n(t)$ is a random variable, the possible values for which are the values $n(t)$ assumed at time t by the individual sample functions of the ensemble. Similarly, at the fixed time $t+\tau$, $n(t+\tau)$ is also a random variable. It then appears that $R(\tau)$ as expressed in Eq. (1.5) is the covariance between these two random variables.

Suppose then that we should find that for some τ, $R(\tau) = 0$. Then the random variables $n(t)$ and $n(t+\tau)$ are uncorrelated, and for the gaussian process of interest to us, $n(t)$ and $n(t+\tau)$ are independent. Hence, if we should select some sample function, a knowledge of the value of $n(t)$ at time t would be of no assistance in improving our ability to predict the value attained by that same sample function at time $t+\tau$[3].

The physical fact about the noise, which is of principal concern in connection with communications systems, is that such noise has a power spectral density $G(f)$ which is uniform over all frequencies. Such noise is referred to as "white" noise in analogy with the consideration that white light is a combination of all colors, that is, colors of all frequencies[4]. Actually there is an upper-frequency limit beyond which the spectral density falls off sharply. However, this upper-frequency limit is so high that we may ignore it for our purposes.

Now, since the autocorrelation $R(\tau)$ and the power spectral density $G(f)$ are a Fourier transform pair, they have the properties of such pairs. Thus when $G(f)$ extends over a wide frequency range, $R(\tau)$ is restricted to a narrow range of τ. In the limit, if $G(f)=I$ (a constant) for all frequencies from $-\infty \leqslant f \leqslant +\infty$, then $R(\tau)$ becomes $R(\tau)=I\delta(\tau)$, where $\delta(\tau)$ is the delta function with $\delta(\tau)=0$ except for $\tau=0$. Since, then, for white noise, $R(\tau)=0$ except for $\tau=0$, Eq. (1.5) says that $n(t)$ and $n(t+\tau)$ are uncorrelated and hence independent, no matter how small τ.

Power Spectral Density of a Sequence of Random Pulses

We shall occasionally need to have information about the power spectral density of a sequence of random pulses. The pulses are of the same form but have random amplitudes and statistically independent random times of occurrence[5]. The waveform (the random process) is stationary so that the statistical features of the waveforms are time invariant. Correspondingly, there is an invariant average time of separation T_s between pulses. We further assume that there is no overlap between pulses.

If the Fourier transform of a single sample pulse $P_1(t)$ is $P_1(f)$ then Parseval's theorem states that the normalized energy of the pulse is

$$E_1=\int_{-\infty}^{\infty} P_1(f)P_1^*(f)\mathrm{d}f=\int_{-\infty}^{\infty}|P_1(f)|^2\mathrm{d}f \tag{1.6}$$

The energy in the range $\mathrm{d}f$ at a frequency f is

$$\mathrm{d}E_1=|P_1(f)|^2\mathrm{d}f \tag{1.7}$$

Now consider a sequence of n successive pulses. Since we assume that the pulses do not overlap, the energy in the range $\mathrm{d}f$ at the frequency f due to the n pulses is:

$$\mathrm{d}E=\mathrm{d}E_1+\mathrm{d}E_2+\cdots+\mathrm{d}E_n=\{|P_1(f)|^2+|P_2(f)|^2+\cdots+|P_n(f)|^2\}\mathrm{d}f \tag{1.8}$$

The average value $\overline{|P(f)|^2}$ of the sequence of n pulses is, by definition

$$\overline{|P(f)|^2}\equiv\frac{1}{n}\{|P_1(f)|^2+|P_2(f)|^2+\cdots+|P_n(f)|^2\} \tag{1.9}$$

so that $\mathrm{d}E$ in Eq. (1.8) can be written

$$\mathrm{d}E=n\overline{|P(f)|^2}\mathrm{d}f \tag{1.10}$$

The average time of separation between pulses is T_s so that n pulses will occur in a time nT_s. The differential energy in the band $\mathrm{d}f$ contained in the time interval nT_s is, from Eq. (1.10)

$$\frac{\mathrm{d}E}{nT_s} = \frac{1}{nT_s} n \overline{|P(f)|^2} \mathrm{d}f = \frac{1}{T_s} \overline{|P(f)|^2} \mathrm{d}f \tag{1.11}$$

The power spectral density in the frequency range $\mathrm{d}f$ is $G(f) = (\mathrm{d}E/nT_s)/\mathrm{d}f$. Hence, from Eq. (1.11), $G(f)$ is:

$$G(f) = \frac{1}{T_s} \overline{|P(f)|^2} \tag{1.12}$$

Hence, whenever we make an observation or measurement of the pulse waveform which extends over a duration long enough so that the average observed pulse shape, such as their amplitudes, widths, and spacings are representative of the waveform generally, we shall find that Eq. (1.12) applies.

In the special case in which the individual pulses are impulses of strength I, then, since in this case $P(f) = I$, we shall have:

$$G(f) = \frac{I^2}{T_s} \qquad -\infty < f < +\infty \tag{1.13}$$

NEW WORDS

1. outcome [ˈautkʌm] n. 结果，结局
2. statistics [stəˈtistiks] n. 统计，统计数字(信息)
   statistic [stəˈtistik] adj. 统计上的；n. 统计量
   statistical [stəˈtistikəl] adj. 统计的，统计学的
3. toss [tɔs] v. 投，掷
4. die [dai] n. 骰子(pl. dice)
   dice [dais] n. 骰子；vi. 掷骰子
5. simultaneously [siməlˈteiniəsli] adv. 同时地
   simultaneous [ˌsiməlˈteinjəs] adj. 同时的
6. intuitive [inˈtju(:)itiv] adj. 直觉的，直观的
   intuitively [inˈtju(:)itivli] adv. 直觉地，直观地
7. analogously [əˈnæləgəsli] adv. 类似地，类比地
8. waveform [ˈweivfɔːm] n. 波形
9. conceptually [kənˈseptjuəli] adv. 概念地
10. collection [kəˈlekʃən] n. 集合，集
11. ensemble [ɑːnˈsɑːmbl] n. 集，总体
    ensemble average 集平均
12. variable [ˈvɛəriəbl] n. 变量，变元
    random variable 随机变量

13. characteristic [kæriktəˈristik] *n.* 特性,特征
    statistical characteristic 统计特性
14. stationary [ˈsteiʃ(ə)nəri] *adj.* 平稳的
    stationary process 平稳过程
15. ergodic [əːˈgɔdik] *adj.* 各态历经的,遍历的
    ergodic process 各态历经过程,遍历过程
16. deterministic [diˌtəːmiˈnistik] *adj.* 确定性的
17. normalize [ˈnɔːməlaiz] *vt.* 使标准化,使规格化
18. normalized [ˈnɔːməlaizd] *adj.* 规格化的,归一化的
19. interval [ˈintəvəl] *n.* 间隔,时间间隔
20. expectation [ˌekspekˈteiʃən] *n.* 期望(值)
21. product [ˈprɔdəkt] *n.* 乘积
22. truncate [ˈtrʌŋkeit] *vt.* 截短,截断
23. periodic [piəriˈɔdik] *adj.* 周期的
24. covariance [kəuˈvεəriəns] *n.* 协方差
25. uncorrelated [ʌnˈkɔrileitid] *adj.* 不相关的
26. gaussian [ˈgauʃiən] *adj.* 高斯的
27. uniform [ˈjuːnifɔːm] *adj.* 均匀的,一致的
28. amplitude [ˈæmplitjuːd] *n.* 振幅
29. overlap [ˌəuvəˈlæp] *v.* (部分)重叠
30. separation [sepəˈreiʃən] *n.* 间隔,距离
31. differential [ˌdifəˈrenʃəl] *n.* 微分,差分
32. spacing [ˈspeisiŋ] *n.* 间隔,间距

PHRASES

1. random process 随机过程
2. on the average 平均,按平均数计算;一般地说
3. make measurement 量度
4. sample function 样本函数
5. statistical average 统计平均(值)
6. probability density function 概率密度函数
7. autocorrelation function 自相关函数
8. in connection with 关于……,与……有关
9. physical significance 物理意义
10. Fourier transform 傅里叶变换
11. power spectral density 功率谱密度

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