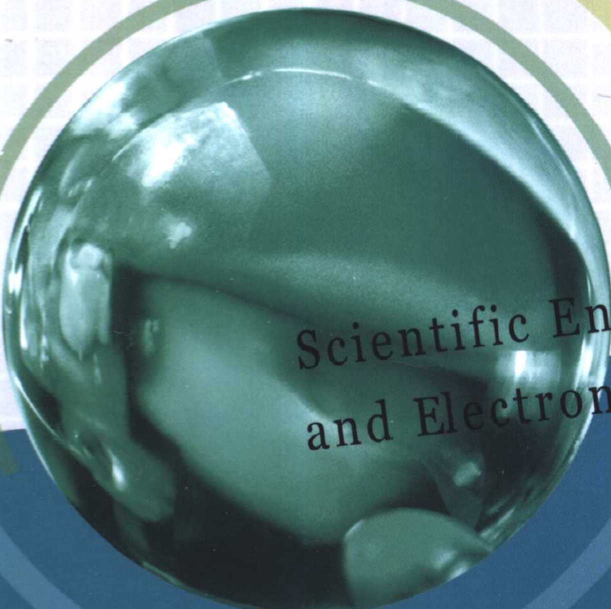
高等院校电子信息类教材

通信与电子信息
科技英语

张敏瑞 张 红 编著



Scientific English on Communications and Electronic Information

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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，通信传输系统、交换、管理这一主线展开，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。

全书共分 18 个单元，每单元包含课文、难点与难句注释、练习、阅读材料及词汇与练习；每篇课文后均配有标注音标的生词表，短语及专业术语表；全书还另附有 3 篇具有实用价值的补充学习资料。

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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前　言

专业英语(或科技英语)是目前我国大学非英语专业三、四年级开设的一门必修课,其目的是使学生学习本专业英语词汇,熟悉相关专业术语,了解科技文章的英文表达方法,提高用英语阅读科技文献以获取最新专业知识的能力。按照通信与电子信息类专业英语课程的要求,在为大学生和研究生讲授专业英语课程十多年的经验基础上,作者编写了这本《通信与电子信息科技英语》教材。

本书内容涉及通信与电子信息类专业的相关知识,按照通信与信息处理基础(随机过程、香农定理、编码、调制、语音处理、图像处理、MATLAB语言),通信传输(数据通信、微波通信、光纤通信、移动通信),交换(ATM、Internet),管理(网络管理、信息安全)这一主线展开,涵盖了通信与电子信息类专业大学生课程的绝大部分内容。本书特点及内容安排如下:

1. 全书:共分18个单元,每个单元又分为课文、练习和阅读材料3个部分。

2. 课文部分:每单元课文后配有生词表、短语及专业术语表,以及难点与难句注释。考虑到学生英语水平的差异,我们在生词表中给出了较为详尽的词汇及释义,同时为了方便学生学习和发音,还注出了每个单词的国际音标。

3. 练习题:每单元课后的练习题都有专业术语的英译汉、汉译英、填空题和问答题4种形式。其中英译汉、汉译英题型主要考核本课应掌握的主要专业词汇及专业术语;填空题主要考核学生在专业英语阅读和写作中应掌握或易出错的问题;问答题根据本课应读懂或了解的专业知识要点以提问的方式作了总结,同时给学生用口语表述专业方面的问题提供了具体题目和练习机会。我们认为这种安排在一定程度上可以减轻学生的学习难度,方便复习总结。

4. 阅读材料:为照顾学习能力较强的同学,进一步扩大本书的阅读范围,我们在每个单元中给出了相应的阅读材料,注出了生词与短语释义,并根据课文内容给出了几个理解问答题。

5. 补充学习资料:本书还安排了3篇补充学习资料,内容包括"相关专业部分大学课程英文名称","科技文常用十进制倍数词头及符号",以及"科技论文英文摘要写作"。这对消除学生口语交流障碍、提高学术论文写作能力等方面都有极大的帮助,这也是本书的主要特色之一。

6. 适用范围: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、参考。

建议本书教学时间为一学期(32～36学时),进度为每周一个单元。书中每个单元内容独立,可根据实际教学要求任意取舍,也便于不同专业的教师讲授和学生自学。考虑到18个单元的独立使用,每单元的生词和短语可能会有少许重复。建议课文作为精讲内

容，阅读材料作为学生自学材料，或者作为训练学生速读的素材。

本书课文和阅读材料的内容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，这些文章涉及面广、信息量大、知识性强、词汇丰富、文笔流畅。源材料出自多个国家的不同作者，具有不同的文风和文体，对开阔读者视野、扩大读者知识面以及提高读者阅读能力应该非常有益。在此，笔者对原始文献的作者们表示衷心感谢！

感谢中国航天科技集团公司五院504研究所博士生导师、通信与电子系统博士周诠研究员，他在本书编写之初，就对本书的编写思路与注意事项等提出过宝贵意见及建议；在编写过程中，他始终耐心地解答我们遇到的专业问题、难句翻译等问题，并为我们审校了部分注释。感谢西安科技大学通信与信息系统专业硕士研究生黄兴、通信与信息工程学院教师柏均、通信与信息系统专业硕士研究生明岸华、邵钢锤，西安电子科技大学信号与信息处理专业博士研究生路陈红，他们在本书原稿的计算机录入及文字编辑方面付出了艰苦的劳动。感谢中国兵器工业集团公司西安机电信息研究所的米辉工程师热情及时地帮我们排除计算机曾出现的各种故障，保证编书所用计算机的正常使用。感谢西安科技大学通信与信息工程学院的王瑜老师在改善工作环境方面的热情帮助。感谢作者的家人和朋友们在本书编写过程中给予的精神鼓励和各方面的大力支持。

在编写和出版过程中，作者得到了所在单位——西安科技大学通信与信息工程学院，西安科技大学教务处教材科，北京邮电大学出版社编辑部的大力支持。作者表示衷心的感谢！

可以说，没有上述单位和个人的大力支持和辛勤付出，作者是不可能在较短的时间内完成本书编写与出版工作的。这里，作者再次表示衷心的感谢！

《通信与电子信息科技英语》是在作者十多年来为大学生和研究生讲授专业英语课程的经验基础上完成，希望能受到大学生、研究生、英语爱好者、相关专业工程技术人员的欢迎。

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。作者联系方式：西安科技大学通信与信息工程学院（邮编 710054），或 zhangminrui@xust.edu.cn，zhanghong@xust.edu.cn。

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作者

2003年10月

于西安科技大学

西安电子科技大学

西安交通大学

CONTENT

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

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

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 the normalized power density is $|V_T(f)|^2/T$. As $T\to\infty$, $v_T(t)\to v_T(t)$, 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

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

The energy in the range df at a frequency f is

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

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

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

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

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

so that dE in Eq. (1.8) can be written

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

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 df contained in the time interval nT_s is, from Eq.(1.10)

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

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

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

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:

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

NEW WORDS

1. outcome ['autkʌm] n. 结果，结局
2. statistics [stə'tistiks] n. 统计；统计数字(信息)

statistic	[stə'tistik]	*adj*.统计上的；*n*.统计量
statistical	[stə'tistikəl]	*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. intuitive	[in'tju(:)itiv]	*adj*.直觉的；直观的
intuitively	[in'tju(:)itivli]	*adv*.直觉地；直观地
6. analogously	[ə'næləgəsli]	*adv*.类似地，类比地
7. conceptually	[kən'septjuəli]	*adv*.概念地
8. simultaneous	[ˌsiməl'teinjəs]	*adj*.同时的，同时发生的
9. collection	[kə'lekʃən]	*n*.集合，集
10. identical	[ai'dentik(ə)l]	*adj*.同一的，同样的
11. individual	[ˌindi'vidjuəl]	*adj*.个别的，单独的
12. ensemble	[ɑ:n'sɑ:mbl]	*n*.集，总体
(ensemble average		集平均)
13. variable	['vɛəriəbl]	*n*.变量；变元
(random variable		随机变量)
14. stationary	['steiʃ(ə)nəri]	*adj*.平稳的
15. ergodic	[ə:'gɔdik]	*adj*.各态历经的，遍历的
(ergodic process		各态历经过程，遍历过程)
16. deterministic	[diˌtə:mi'nistik]	*adj*.确定性的
17. normalize	['nɔ:məlaiz]	*vt*.使标准化，使规格化
normalized	['nɔ:məlaizd]	*adj*.规格化的，归一化的
18. expectation	[ˌekspek'teiʃən]	*n*.期望(值)
19. product	['prɔdəkt]	*n*.乘积
20. truncate	['trʌŋkeit]	*vt*.截短；截断
21. periodic	[piəri'ɔdik]	*adj*.周期的
22. covariance	[kəu'vɛəriəns]	*n*.协方差
23. uncorrelated	[ʌn'kɔrileitid]	*adj*.不相关的
24. uniform	['ju:nifɔ:m]	*adj*.均匀的，一致的
25. overlap	[ˌəuvə'læp]	*v*.(部分)重叠
26. separation	[sepə'reiʃən]	*n*.间隔，距离
27. spacing	['speisiŋ]	*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. statistical characteristic	统计特性
8. autocorrelation function	自相关函数
9. in connection with	关于……,与……有关
10. physical significance	物理意义
11. Fourier transform	傅里叶变换
12. power spectral density	功率谱密度
13. be at liberty to(do)	被允许;可随意
14. gaussian process	高斯过程
15. physical fact	外界存在的事实
16. upper-frequency limit	频率上限
17. fall off	下降,减少
18. in the limit	在极限情况下
19. delta function	函数,狄拉克函数
20. random pulse	随机(杂乱)脉冲
21. time invariant	时不变的
22. Parseval's theorem	帕斯瓦尔定理
23. statistically independent	统计独立
24. successive pulse	连续脉冲
25. be representative of	表示,代表,代表……的特征

NOTES

[1] 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.

因此,我们会预期平均掷 6 次骰子会有 1 次得到特定的结果。类似地,当掷很多骰子时,有 1/6 的骰子会得到特定的结果。

- out of (from among)表示"从……中"。例如:
  five out of six votes 六人中有五人投票
- on the average 平均,按平均数计算;一般地说

[2] Throughout this text we shall assume that the random processes with which we shall have occasion to deal are ergodic.

在整篇课文中,我们假定要研究的随机过程均为各态历经过程。

- occasion *n.* 场合,时机,机会

have occasion 有……的理由；有必要……

have no occasion 没有……的理由；没有必要……

- deal *v.* 论及，论述

  a book that deals with the Middle Ages. 一本讨论中世纪时候的书

- random process 随机过程

  （注：随机过程为通信与电子信息类专业的一门重要理论基础课，其他有关课程的英文名称请参阅本课课后补充学习资料 1。）

[3] 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 $t+\tau$.

因此，如果我们选定某样本函数 $n(t)$，则它在 t 时刻的值不能有助于预测相同样本函数在 $t+\tau$ 时刻的值。

- some *adj.* 某一，任一，例如：

  He went to some place in Africa. 他到非洲某地去了。

- knowledge of 对……的认识

[4] 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.

这种噪声称为“白”噪声，类似于白光是所有颜色光即所有频率有色光的混合。

- analogy [əˈnælədʒi] *n.* 类似，类推，例如：

  in a rough analogy 大致类似地

[5] The pulses are of the same form but have random amplitudes and statistically independent random times of occurrence.

这些脉冲形状相同，但具有随机幅度，并且出现次数随机、统计独立。

EXERCISES

Ⅰ. Please translate the following words and phrases into Chinese.

1. sample function
2. ensemble average
3. physical significance
4. a Fourier transform pair
5. deterministic waveform
6. in the limit
7. time invariant
8. an upper-frequency limit
9. Parseval’s theorem
10. random pulses

Ⅱ. Please translate the following words and phrases into English.

1. 随机过程
2. 统计平均
3. 随机变量
4. 自相关函数
5. 傅里叶变换
6. 功率谱密度
7. 概率密度函数
8. 高斯过程
9. 平稳过程
10. 统计独立

11. 时间平均(值)
12. 统计特性
13. 各态历经过程
14. δ函数(狄拉克函数)

Ⅲ. Fill in the blanks with the missing word(s).

1. The ensemble averages will be identical ________ the statistical averages and may be represented by the same symbols.
2. The averages determined by measurements ________ a single sample function ________ successive times will yield a time average, which we represent as $\langle n^2(t_1)\rangle$.
3. Suppose, for example, that the statistical characteristics of the sample functions ________ the ensemble were changing with time.
4. For it may happen that while each sample function is stationary the individual sample functions may differ statistically ________ one another.
5. As an extension of that result we shall define the power spectral density of a random process ________ the same way.
6. It is ________ interest to inquire whether $G(f)$ defined ________ Eq. (1.2) for a random process has a physical significance which corresponds to the physical significance of $G(f)$ for deterministic waveforms.
7. Correspondingly, we state, without proof, that when $G(f)$ is defined ________ a random process, as in Eq. (1.2), ________ the transform of $R(\tau)$, then $G(f)$ has the significance that

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

8. Hence, if we should select some sample function, a knowledge of the value of $n(t)$ at time t would be ________ no assistance ________ improving our ability to predict the value attained by that same sample function at time $t+\tau$.
9. Hence, whenever we make an observation or measurement of the pulse waveform which extends ________ 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.
10. Let us select a section of this waveform which extends ________ $-T/2$ ________ $T/2$.
11. Since we have assumed an ergodic process, we are at liberty to ________ (perform, performing) the averaging ________ any sample function of the ensemble, since every sample function will yield the same result.

Ⅳ. Answer the following questions according to the text.

1. Please describe the relationship between the ergodic process and the stationary process.
2. What are random pulses?
3. What is the relationship between the power spectral density $G(f)$ and the