

LDS&S Newsletter 2005

Issued annually for the textbook *Linear Dynamic Systems and Signals*
Zoran Gajic, Prentice Hall, Upper Saddle River, New Jersey, 2003

Textbook website: <http://www.ece.rutgers.edu/~gajic/systems.html>

■ ***Solutions Manual***

The first edition of the *Solutions Manual for Linear Dynamic Systems and Signals* textbook was published in May 2003. The solutions manual is available in its electronic form. Instructors using this textbook should contact either Professor Zoran Gajic or Prentice Hall to get information how to download the *Solutions Manual*.

Problems 1.9, 4.13, 4.44b, 4.60, 4.62, 5.8c, 6.4, 8.3, and 8.7 were corrected in December 2004. The author is thankful to Professor Christian Fayomi from the University of Quebec at Montreal, Canada, for indicated to some corrections/typos. Preface is also updated in December 2004.

■ ***Solutions to MATLAB Laboratory Experiments***

The first edition of the *Solutions to MATLAB Laboratory Experiments* for the textbook *Linear Dynamic Systems and Signals* was published in August 2003. The supplement *Solutions to MATLAB Laboratory Experiments* is also available in the electronic pdf-form. Instructors should contact either Professor Zoran Gajic or Prentice Hall to get an access to this supplement.

The author is indebted to Professor Christian Fayomi from the University of Quebec at Montreal, Canada, for providing useful improvements and corrections to Experiment 3 (page 17) and Experiment 9 (page 97). The author is thankful to Professor Vojislav Kecman from the University of Auckland, New Zealand, for correcting Experiment 6 (pages 36, 38, and 41). Preface was also updated in February 2005.

■ ***PowerPoint Slides and PDF-Transparencies***

1005-page PowerPoint-slides and PDF-transparencies were completed in October 2003. The slides/transparencies are available only in electronic forms. Please contact either Professor Gajic or Prentice Hall to get the link and password information.

The slides and transparencies, updated/corrected in January 2005, are: Fourier Transform, Fourier Series in System Analysis, Laplace Transform, Laplace Inverse, and Inverse Z-Transformation.

■ ***CD with the Textbook Supplements***

A CD containing the textbook supplements was updated in February 2005, featuring new items (in addition to those from 2004 edition):

- Figures from problems sections;

- Sample exams and their solutions;
- Newsletters with featured topics.

Instructors interested in the updated CD should send an email request to Professor Zoran Gajic at gajic@ece.rutgers.edu

■ *List of Textbook Corrections/Typos*

The list of textbook corrections (divided into four parts: text, problems, answers, MATLAB programs) was updated in December 2004. The author is thankful to Professor Christian Fayomi from the University of Quebec at Montreal, Canada, and Ms. Qiao Chen, an undergraduate student from Rutgers University, for indicating to some typos and required corrections. The updated list of textbook corrections is posted on the textbook website <http://www.ece.rutgers.edu/~gajic/systems.html>.

■ *Translations*

The book was translated into the *Chinese Simplified language* and published in 2004 by Pearson Education North Asia Ltd (Hong Kong) and Xi'an Jiaotong University Press, Shanghai, China.

■ *Featured Topic:*

Linear System Zero-State Response to Semi-Periodic Inputs

In contrast to periodic (everlasting) inputs, $f(t) = f(t + T)$, $T < \infty$, $-\infty \leq t \leq \infty$, that produce pure periodic linear system outputs (obtained via the Fourier series), the semi-periodic inputs, defined by $f_s(t) = f_s(t + T)$, $T < \infty$, $0 \leq t \leq \infty$ and $f_s(t) < 0$, $t < 0$, excite the natural system modes (producing the system response transient component, in addition to the steady state periodic component of the system response). Periodic and semi-periodic signals can also be represented via infinite sums respectively as

$$f(t) = \sum_{i=-\infty}^{i=\infty} f_p(t - iT), \quad f_s(t) = \sum_{i=0}^{i=\infty} f_p(t - iT) \quad (1)$$

where $f_p(t)$ is the signal defined on the interval from 0 to T , which repeats its self infinitely many times either in the periodic or semi-periodic fashion. It was shown in Problem 4.5 that the Laplace transform of a semi-periodic signal defined in (1) is given by

$$F_s(s) = \mathcal{L}\{f_p(t)\} = F_p(s)(1 + e^{-sT} + e^{-2sT} + \dots) = F_p(s) \frac{1}{1 - e^{-sT}} \quad (2)$$

$$F_p(s) = \mathcal{L}\{f_p(t)\} = \int_0^T f_p(t) e^{-st} dt$$

Hence, the s -domain term $1/(1 - e^{-sT})$ indicates the signal's semi-periodicity in the time domain.

Let the linear system be defined by its transfer function $H(s)$. The zero-state component of the linear time-invariant system response is given by

$$y_{zs}(t) \leftrightarrow H(s)F_s(s) = H(s)F_p(s) \frac{1}{1 - e^{-sT}} = Y_p(s) \frac{1}{1 - e^{-sT}}, \quad Y_p(s) = H(s)F_p(s) \quad (3)$$

We need first find $y_p(t) \leftrightarrow Y_p(s)$. Then, the required system zero-state response is

$$y_{zs}(t) = \sum_{i=0}^{\infty} y_p(t - iT) \quad (4)$$

In most cases, the expression for $F_p(s)$, obtained by performing integration defined in (2), is given by $F_p(s) = F_{1p} + F_{2p}e^{-sT} \leftrightarrow y_{1p} + y_{2p}(t - T)$. In such cases, the sought zero-state response is given by

$$y_{zs}(t) = \sum_{i=0}^{\infty} [y_{1p}(t - iT) + y_{2p}(t - iT - T)] \quad (5)$$

Note that in general, $F_p(s)$ might not be a rational function (ratio of two polynomials), in which case we have to use the complex variable integration technique known as contour integration in order to find the Laplace inverse of $F_p(s)$.

When the linear time-invariant system has non-zero initial conditions, the initial conditions will produce the zero-input component of the system response so that the complete system response is given by $y(t) = y_{zi}(t) + y_{zs}(t)$.

The problem of finding the linear time-invariant system response due to semi-periodic inputs is common for electrical circuits. Several problems of this type can be found in the textbook, see Problems 4.60-4.62.

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