**Application Form For Opening Graduate Courses**

School (Department/Institute)：School of Information Science and Engineering

Course Type: New Open □ Reopen √ Rename □**（**Please tick in □, the same below）

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| Course Name | | Chinese | 现代数字信号处理 | | | | | | | | | | |
| English | Advanced Digital Signal Processing | | | | | | | | | | |
| Course Number | | | S004103 | | | Type of Degree | | | Ph. D |  | Master | | √ |
| Total Credit Hours | | | 54 | In Class Credit Hours | 54 | | Credit | 3 | Practice | experiment | Computer-using Hours | | 8 |
| Course Type | | | □Public Fundamental √ Major Fundamental □Major Compulsory □Major Elective | | | | | | | | | | |
| School (Department) | | | School of Information Science and Engineering | | | Term | | Autumn | | | | | |
| Examination | | | A. √ Paper（□ Open-book √ Closed-book） B. □Oral  C. □Paper-oral Combination D. □ Others | | | | | | | | | | |
| Chief  Lecturer | Name | | Luxi Yang | | | Professional Title | | Professor | | | | | |
| E-mail | | lxyang@seu.edu.cn | | | Website | | http://ypyb.seu.edu.cn:80/scr2008-personal/c/S004103 | | | | | |
| Teaching Language used in Course | | | Chinese | | | Teaching Material Website | | http://ypyb.seu.edu.cn:80/scr2008-personal/c/S004103 | | | | | |
| Applicable Range of Discipline | | | first-class discipline | | | | | Name of First-Class Discipline | | Communications and Information Engineering | | | |
| Number of Experiment | | | 4 | | | Preliminary Courses | | Signals and Systems | | | | | |
| Teaching Books | | | Textbook Title | | | Author | | Publisher | | Year of Publication | | Edition Number | |
| Main Textbook | | | Advanced Digital Signal Processing | | | Luxi Yang | | Science Press | | 2007 | | 1 | |
| Main Reference Books | | | Digital Signal Processing | | | Guangshu Hu | | Tsinghua University Press | | 2000 | | 2 | |
| Adaptive Filter Theory | | | Simon Haykin | | Prentice Hall; Publishing House of Electronics Industry in China | | 1998 | | 3 | |
| Advanced Signal Processing | | | Xianda Zhang | | Tsinghua University Press | | 1995 | | 1 | |

1. **Course Introduction (including teaching goals and requirements) within 300 words:**

This course focuses on problems, algorithms, and solutions for processing signals in stationary and non-stationary environment. It will provide students with the basics of stochastic processes, estimation, transformation, spectral analysis, optimal filtering and adaptive filtering techniques present in modern digital signal processing systems. The class is designed as an advanced statistical signal processing course in which students will build a strong foundation in approaching problems in such diverse areas as acoustic, sonar, radar, multimedia and communications signal processing. Understanding of the theoretical foundations of advanced signal processing theory will be achieved through a combination of theoretical and computer-based homework assignments. The class meets for 4 lecture hours per week for 16 weeks.

1. **Teaching Syllabus (including the content of chapters and sections. A sheet can be attached):**

**Chapter 1 Fundamentals of Discrete-time Signal processing**

1. Introduction to Digital Signals and Digital Signjal Processing (DSP)

2. Digital Filters

3. Transforms for Digital Signals: a) z-Transform, b) DTFT, c) DFT and FFT

4. Special Sequences and Special Filters: a)All-Pass, b) Minimum Phase, c) Linear Phase, d) Positive Semi-definite

**Chapter 2 Fundamentals of Stochastic Discrete-time Signal Analysis**

1. Random Processes

2. Filtering Random Processes

3. Spectral Factorization

4. Special Types of Random Processes

5. Basic orthogonal transforms: a) Orthogonal transforms in Hilbert space, b) K-L transform and principal component analysis, c) Discrete-time Cosine transform (DCT)

6. Basic methods of parameter estimation: a) Principles of parameter estimation, b) Performance bounds, c) Sample mean and sample autocorrelation, d) Least squares (LS) estimation, e) Linear minimum mean squares estimation (LMMSE), f) Maximum likelihood (ML) estimation, g) Bayes estimation

**Chapter 3 Linear Prediction and Lattice Filters**

1. Basic Model of Linear Prediction and the autocorrelation method

2. The equivalence between all-pole modeling of AR process and linear prediction

3. Levinson-Durbin recursion algorithm

4. Step-up, step-down, and inverse recursion

5. Schur recursion

6. Levinson recursion

7. The covariance algorithm for linear prediction

8. Forward and backward linear prediction and Lattice filters

9. The Burg recursion algorithm－linear prediction based on Lattice modeling

10. The modified covariance algorithm for linear prediction

**Chapter 4 Linear Modeling of Random Sequences**

1. ARMA modeling of random sequences

2. AR modeling of random sequences

3. MA modeling of random sequences

4. Applications and examples

**Chapter 5 Power spectrum estimation**

1. Classical methods

2. The minimum variance method

3. The maximum entropy method

4. Parametric spectrum estimation

5. Comparison of several methods

6. Subspace methods for frequency estimation

**Chapter 6 Wiener filtering and Kalman filtering**

1. FIR Wiener filters: a) FIR Wiener filtering, b) FIR Wiener linear prediction, c) Noise cancelling by FIR Wiener filters, d) FIR Wiener deconvolution ---MMSE equalizer, e) FIR Wiener Lattice filters

2. IIR Wiener filters: a) Noncausal IIR Wiener filtering, b) Noncausal IIR Wiener deconvolution, c) Causal IIR Wiener filtering, d) Causal IIR Wiener linear prediction

3. Discret time Kalman filtering and Applications

**Chapter 7 Adaptive filtering**

1. Adaptive direct-form FIR filters: a) Steepest Descent algorithm, b) Least-Mean-Square (LMS) algorithm, c) Properties of the LMS, d) Normalized and frequency-domain LMS, e) LMS-Newton algorithm, f) Transform-domain LMS algorithm, g) Affine projection algorithm, h) Gradient adaptive lattice methods, i) Adaptive joint process estimator

2. Recursive least squares adaptive algorithms: a) Three type of RLS algorithms, b) Properties of RLS

3. Applications of adaptive filtering

**Chapter 8 Multi-rate Digital Signal Processing and Filter Banks**

1. The sampling rate alteration: a) Factor-of-M down-sampling, b) Factor-of-L up-sampling, c) Fractional sampling rate alteration

2. Cascade equivalence of the basic sampling rate alteration devices

3. Multistage design of Decimator and Interpolator

4. The polyphase decomposition: a) The decomposition, b) FIR filter structures based on the polyphase decomposition, c) Efficient implementation of Decimator and Interpolator

5. Digital filter banks: a) Uniform DFT filter banks and their polyphase implementations, b) *L*th-band filters, c) Two-channel filter banks and their optimal design, *L*-channel filter banks (Cosine-modulated filter banks)

1. **Teaching Schedule:**

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| Week | Course Content | Teaching Method |
| 1 | Chapter 1 Fundamentals of Discrete-time Signal processing | Lecture |
| 2 | Chapter 2 Fundamentals of Stochastic Discrete-time Signal Analysis #1 | Lecture |
| 3 | Chapter 2 Fundamentals of Stochastic Discrete-time Signal Analysis #2 | Lecture |
| 4 | Chapter 2 Fundamentals of Stochastic Discrete-time Signal Analysis #3  Chapter 3 Linear Prediction and Lattice Filters #1 | Lecture |
| 5 | Chapter 3 Linear Prediction and Lattice Filters #2 | Lecture |
| 6 | Chapter 3 Linear Prediction and Lattice Filters #3 | Lecture |
| 7 | Chapter 4 Linear modeling of Digital Random Signals | Lecture |
| 8 | Problem Solving and Computer Projects Analysis | Lecture and Seminar |
| 9 | Chapter 5 Power spectrum estimation #1 | Lecture |
| 10 | Chapter 5 Power spectrum estimation #2 | Lecture |
| 11 | Chapter 5 Power spectrum estimation #3 | Lecture |
| 12 | Chapter 6 Wiener filtering and Kalman filtering #1 | Lecture |
| 13 | Chapter 6 Wiener filtering and Kalman filtering #2 | Lecture |
| 14 | Chapter 7 Adaptive filtering #1 | Lecture |
| 15 | Chapter 7 Adaptive filtering #2 | Lecture |
| 16 | Chapter 7 Adaptive filtering #3  Chapter 8 Multi-rate Digital Signal Processing and Filter Banks #1 | Lecture |
| 17 | Chapter 8 Multi-rate Digital Signal Processing and Filter Banks #2 | Lecture |
| 18 | Problem Solving and Computer Projects Analysis | Lecture and Seminar |

Note: 1.Above one, two, and three items are used as teaching Syllabus in Chinese and announced on the Chinese website of Graduate School. The four and five items are preserved in Graduate School.

2. Course terms: Spring, Autumn , and Spring-Autumn term.

3. The teaching languages for courses: Chinese, English or Chinese-English.

4. Applicable range of discipline: public, first-class discipline, second-class discipline, and third-class discipline.

5. Practice includes: experiment, investigation, research report, etc.

6. Teaching methods: lecture, seminar, practice, etc.

7. Examination for degree courses must be in paper.

8. Teaching material websites are those which have already been announced.

9. Brief introduction of chief lecturer should include: personal information (date of birth, gender, degree achieved, professional title), research direction, teaching and research achievements. (within 100-500 words)

1. **Brief Introduction of Chief lecturer:**

**Luxi Yang**, male, was born in 1964. Hereceived the M.S. and Ph. D. degree in electrical engineering, from the Southeast University, Nanjing, China, in 1990 and 1993, respectively. Since 1993, he has been with the Department of Radio Engineering, Southeast University, where he is currently a Professor of information systems and communications and the director of Digital Signal Processing Division, and also served as a doctoral students advisor. His current research interests include signal processing for wireless communications, MIMO communications, cooperative relaying systems, and statistical signal processing. He is the author or coauthor of two published books and more than 160 journal papers, and holds 20 patents. Prof. Yang received the first- and second-class prizes of Science and Technology Progress Awards of the State Education Ministry of China for 3 times, and the first-class prizes of Science and Technology Progress Awards of Jiang-su Province of China for 2 times. He is currently a Member of Signal Processing Committee of Chinese Institute of Electronics, Chapter Chair of Signal Processing, IEEE Nanjing Section.

1. **Lecturer Information (include chief lecturer)**

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| Lecturer | Discipline  (major) | Office  Phone Number | Email | Address | Postcode |
| Luxi Yang | Signal and Information Processing | 83792481 | lxyang@seu.edu.cn | School of Information Science and Engineering, Sotheast University, Nanjing, Jiang-su 210096, China | 210096 |