**Application Form For Opening Graduate Courses**

School (Department/Institute)： Information Science and Engineering

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

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| Course Name | Chinese | 数字通信原理与系统 |
| English | Digital Communications Principles and Systems |
| Course Number |  | Type of Degree  | Ph. D |  | Master | √ |
| Total Credit Hours | 54 | In Class Credit Hours | 48 | Credit | 3 | Practice | experiment | Computer-using Hours |  |
| Course Type | □Public Fundamental √ Major Fundamental □Major Compulsory □Major Elective |
| School (Department) | Information Science and Engineering | Term | Spring |
| Examination | A. √ Paper（□ Open-book √ Closed-book） B. □Oral C. □Paper-oral Combination D. □ Others  |
| ChiefLecturer | Name | Zhang Yuan, Huang Yongming | Professional Title | Associate Professor |
| E-mail | {y.zhang, huangym}@seu.edu.cn | Website |  |
| Teaching Language used in Course | Chinese | Teaching Material Website |  |
| Applicable Range of Discipline | second-class discipline | Name of First-Class Discipline | Electronic and Communication Engineering |
| Number of Experiment | 2 | Preliminary Courses | Matrix Theory, Random Process, Digital Signal Processing |
| Teaching Books | Textbook Title | Author | Publisher | Year of Publication | Edition Number |
| Main Textbook | Digital Communications | John G Proakis | McGraw-Hill Companions | 2001 | 4 |
| Main Reference Books | Digital Communications | John G Proakis | McGraw-Hill Companions | 2007 | 5 |
| Fundamentals of Wireless Communication | David Tse and Pramod Viswanath | Cambridge University Press | 2005 | 1 |
| Wireless Communications | Andrea Goldsmith | Cambridge University Press | 2005 | 1 |

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

The goals are to train the new generation of wireless communication engineers. In particular, our goals are to understand the state-of-the-art of all aspects of digital communications technologies including source coding, channel modeling, transmitter/receiver design, and performance evaluation, and to understand how digital communications systems work as a whole.

1. **Teaching Syllabus (including the content of chapters and sections. A sheet can be attached):**
	1. **Outline of digital communications**: Basic components of digital communications, and characteristic of wireless channels; Mathematical model of digital communication systems, and development of digital communications.
	2. **Statistics and stochastic processes**: Definitions and applications of random variables and stochastic processes; Typical random variables and stochastic processes used in the design of digital communication system; The output and representation of a time-invariant linear system input with a random signal; The sampling theorem for bandwidth limited stochastic processes.
	3. **Source coding**: System model of source coding, definition of information entropy; Source coding theorem; Typical source coding algorithms including Huffman, Lempel-Ziv etc.; The basic methods to quantize analogy signals such as PCM and DPCM.
	4. **Representation of communication signals and systems**: Mathematical representation of communication signals and systems; The equivalent baseband representation of band-pass narrowband signal and system; Concept of signal space, the mathematical representation and features of typical digital modulation signals.
	5. **Optimal receivers for AWGN channels**: The design of optimal receiver for modulated signal through AGWN channels, including ML and MAP receivers; The principle and model of decorrelation demodulator and matched filter; The methods to evaluate error rates of typical modulated signals.
	6. **Carrier and symbol synchronization**: The principle and diagram of carrier recovery and symbol synchronization for modulated signals; The algorithms of typical carrier phase estimation and symbol timing.
	7. **Cannel capacity and channel model**: Typical modeling methods for channels such as Rayleigh and Rice wireless channels; Concepts of channel capacity and Shannon Theorem; Modeling of multiple-antenna channels.
	8. **Channel coding**: The principle of channel coding for wireless communication systems; The encoder/decoder and diagrams of linear block code and convolutional code, including hard/soft decoder, Viterbi decoder.

(9) **Digital communications through band-limited channels:** Signal design for band-limit channels, including Nyquist rule, partial-response signals, and signal design for channels with distortion; optimal receiver for channels with AWGN and ISI, including ML receiver, linear equalization, and decision-feedback equalization; Turbo equalization.

(10) **Adaptive equalization:** LMS and RLS based adaptive equalization algorithms, including adaptive linear equalization and adaptive decision-feedback equalization; the convergence and computation complexity analysis; blind equalization.

(11) **Multichannel and multicarrier systems:** Multi-channel digital communications in AWGN channels; multi-carrier communications, including OFDM modulation and demodulation, FFT implementation of OFDM systems, bit and power allocation in OFDM systems, and the PAR problem.

(12) **Spread spectrum signals for digital communications:** Direct sequence spread spectrum signals, including error performance, applications, and the effect of interference on DS spread spectrum systems; frequency hopping spread spectrum signals, including error performance, applications, and the effect of interference on FH spread spectrum systems; synchronization of spread spectrum systems.

(13) **Fading channels characterization and signalling:** Statistical model of fading channels, including Raleigh, Ricean, and Nakagami model; binary digital signals transmission over fading channel; anti-fading techniques, including diversity technique and Rake receiver.

(14) **Fading channels capacity and coding:** Ergodic and outage capacity of fading channels; coding for fading channels, including trellis-coded modulation and bit-interleaved coded modulation; coding in frequency domain, and the cutoff rate for fading channels.

(15) **Multi-antenna systems:** Channel models for multi-antenna systems, signal transmission and detection in MIMO systems; capacity of MIMO channels; spread spectrum signals and multicode transmission for MIMO systems; bit-interleaved coding and space-time coding for MIMO channels.

(16) **Multiuser communications:** Capacity of FDMA、TDMA、CDMA multiple access methods; multiuser detection in CDMA uplink, including the optimal multiuser receiver and suboptimal detectors; downlink multiuser MIMO systems, including linear and nonlinear precoding techniques; Aloha and CSMA-CD random access protocols and performance.

1. **Teaching Schedule:**

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| Week | Course Content | Teaching Method |
| 1 | Outline of digital communications  | lecture (Huang) |
| 2 | Statistics and stochastic processes in communication systems | lecture (Huang) |
| 3 | Source coding | lecture (Huang) |
| 4 | Representation of communication signals and systems | lecture (Huang) |
| 5 | Optimal receivers for AWGN channels | lecture (Huang) |
| 6 | Carrier and symbol synchronization | lecture (Huang) |
| 7 | Cannel capacity and channel model | lecture (Huang) |
| 8 | Channel coding | lecture (Huang) |
| 9 | Digital communications through band-limited channels | lecture (Zhang) |
| 10 | Adaptive equalization | lecture (Zhang) |
| 11 | Multichannel and multicarrier systems | lecture (Zhang) |
| 12 | Spread spectrum signals for digital communications | lecture (Zhang) |
| 13 | Fading channel characterization and signalling | lecture (Zhang) |
| 14 | Fading channel capacity and coding | lecture (Zhang) |
| 15 | Multi-antenna systems | lecture (Zhang) |
| 16 | Multiuser communications | lecture (Zhang) |
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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:**

**Zhang Yuan**, male, born in June 1977, received the doctoral degree from the Department of Radio Engineering of Southeast University in 2004, joined the National Mobile Communications Research Lab (NCRL) in 2005, and is currently an associate professor. He has been extensively involved in many national research projects in the fields of mobile communications. His personal research interests include wireless communication and networking design, analysis and implementation.

**Huang Yongming**, male, born in Aug. 1977, received the master degree from Nanjing University in China, and the PhD degree from the Southeast University in China, in 2003 and 2007, respectively. Since 2007 he has been an assistant professor in the school of information science and Engineering, Southeast University. In December 2008 he joined in the Signal Processing Lab, Electrical Engineering, Royal Institute of Technology (KTH) as a post-doctor. His current research interest includes MIMO communication systems, multiuser MIMO communications and relay based cooperative communications. He has been extensively involved in many national research projects in the fields of mobile communications and has published several papers in first-class international journal such as IEEE T-SP/T-WC. He also hold several national patents in the fields of MIMO communications.

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

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| Lecturer | Discipline (major) | Email | Address | Postcode |
| Zhang Yuan | Communication and Information System | y.zhang@seu.edu.cn | National Comminications Research Lab, Southeast University | 210096 |
| Huang Yongming | Signal and information processing | huangym@seu.edu.cn | Room 211, Jianxiong Hall | 210096 |