New Jersey Institute of Technology
Department of Electrical & Computer Engineering
Ph.D. Qualifying Examination Format

(Revised 5/4/2009)

Each Ph.D. student is required to select a *Doctoral Study Area* (“Area”) from the following five options:

1) Communications, Signal Processing and Microwaves
2) Computer Architecture and Systems
3) Computer Networking
4) Solid State, VLSI and Electro-Optics Systems
5) Intelligent Systems

Doctoral Study Area Requirements are satisfied by taking and passing the written Ph.D. Qualifying Examination (comprised of two parts) in the *selected Area* as detailed below.

1) <u>Communications, Signal Processing and Microwaves (CSM) Area</u>

Each student must select a Specialty Track (“Track”). The student has to pass the written Ph.D. Qualifying Examination comprised of Part I (Fundamental) and Part II (Advanced). Effective AY 2008-2009, there will be three separate Ph.D. Qualifying Examinations Specialty Tracks (“Tracks”) for CSM Area students:

a) Communications Track
b) Signal Processing Track
c) Microwaves Track

This exam is based on recommended subjects/topics in the area of Communications, Signal Processing and Microwaves (the topics as well as pointers for the students in terms of books, references, and courses that cover those subjects are provided as follows).

PART I (Fundamental)

Exam duration is 3 hours. The student must answer 6 out of 12 problems.

A. Communications and Signal Processing Specialty Tracks

i. **Linear Systems (relevant course: ECE 601)**
Text: B.P. Lathi, *Linear Systems and Signals*, 2nd Edition, Oxford University Press, 2005.
Time domain and complex domain representation of signals and systems. State-space analysis of continuous-time and discrete-time systems.

ii. Digital Signal Processing (relevant course: ECE 640)
Text: S.K. Mitra, Digital Signal Processing, A Computer-Based Approach. 3rd Ed., McGraw Hill, 2006.
Discrete-time signals and systems, Fast Fourier Transform, filter structures, the Z-transform, frequency response of LTI systems, all-pass filters, minimum-phase filters, FIR and IIR filters, filter design, the discrete Fourier transform.

iii. Communication Systems (relevant course: ECE 642)
Text: A.B. Carlson *Communication Systems.*
Linear CW modulation, exponential CW modulation, CW modulation systems, baseband digital transmission, multiplexing and switching, system noise calculations.

iv. **Random Signals (relevant course: ECE 673)**
Text: Leon-Garcia, *Probability and Random Processes,*and Papoulis, *Probability, Random Variables, and Stochastic Processes*
Basic concepts in probability, pdfs of common distributions, random variables and their functions (1-D, 2-D, and m-D), (3) statistics (moments and covariance matrix) of random variables, WSS and independent random processes, properties, applications, the central limit theorem, Chebyshev inequality, ergodic theorem, LTI systems with random inputs, correlation function, power spectral density and I/O relations.

B. Microwaves Track

i. Linear Systems (relevant course: ECE 601)
Text: B.P. Lathi, *Linear Systems and Signals,* 2nd Edition, Oxford University Press, 2005.

Time domain and complex domain representation of signals and systems. State-space analysis of continuous-time and discrete-time systems.

ii. Electromagnetics (relevant course: ECE 620)
Text: R. Harrington, *Time-Harmonic Electromagnetic Fields.* Wiley-IEEE Press, 2001; and C.A. Balanis, *Advanced Engineering Electromagnetics.* Wiley, 1989.
Static electric and magnetic fields; time harmonic (ac) electromagnetic fields, plane electromagnetic waves in free space and the influence of planar boundaries; transmission line theory in the time and frequency domains; uniform waveguides.

iii. Wave Propagation (relevant course: ECE 622)
Text: G.Tyras,*The Radiation and Propagation of Electromagnetic Waves,*. Academic Press, 1969.

iv. Random Signals (relevant course: ECE 673)
Text: Leon-Garcia, *Probability and Random Processes,* and Papoulis, *Probability, Random Variables, and Stochastic Processes*
Basic concepts in probability, pdfs of common distributions, random variables and their functions (1-D, 2-D, and m-D), (3) statistics (moments and covariance matrix) of random variables, WSS and independent random processes, properties, applications, the central limit theorem, Chebyshev inequality, ergodic theorem, LTI systems with random inputs, correlation function, power spectral density and I/O relations.

PART II (Advanced)

Exam duration is 3 hours. The student must answer 6 out of 9 problems. Student must take this exam in the declared *Track*. Otherwise, student fails this exam.

II.A Communications Track

i. Advanced Signal Processing (relevant course: ECE 740)
Text: S. Haykin, *Adaptive Filter Theory.*
Models of discrete-time processes, Yule-Walker equations, innovations process, Wiener filtering theory, linear prediction, forward-backward prediction, Levinson-Durbin recursion, Burg formula, Kalman filtering, method of least-squares, adaptive processing, the LMS algorithm, Q-R decomposition, block transforms, multirate systems.

ii. Digital Communications (relevant courses: ECE 742, 755)
Text: Salehi and Proakis, *Communication Systems Engineering*; and
Proakis, *Digital Communications*
Pulse modulation, PCM, baseband signals, matched filter, signals space representation, Grams-Schmidt orthogonalization, digital modulations (BPSK, MSK, M-PSK, QAM, DPSK, orthogonal signalling), power spectra of digital modulations, optimum receivers in white Gaussian noise, performance of the optimum receivers, bandlimited channels, intersymbol interference, equalization, basics of multipath fading channels, spread spectrum communications, elements of information theory, source coding theorem, channel capacity, channel coding theorem, elements of coding, linear block codes, convolutional codes, Trellis coding.

iii. Statistical Decision Theory (relevant course: ECE 777)
Text: L. Scharf, *Statistical Signal Processing*; and S. Kay, *Statistical Signal Processing*
Sufficiency, MVUB estimators, binary hypothesis, the Neyman-Pearson detector, detection with multiple observations, detection of signals with unknown parameters, the CFAR receiver, Bayes detectors, min-max tests.

II.B Signal Processing Track

i. Advanced Signal Processing (relevant course: ECE 740)
Text: S. Haykin, *Adaptive Filter Theory*
Models of discrete-time processes, Yule-Walker equations, innovations process, Wiener filtering theory, linear prediction, forward-backward prediction, Levinson-Durbin recursion, Burg formula, Kalman filtering, method of least-squares, adaptive processing, the LMS algorithm, Q-R decomposition, block transforms, multirate systems.

ii. Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets (relevant course: ECE 747)
Text: A.N. Akansu and R.A. Haddad, *Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets*. 2nd Edition, Academic Press, 2001.
Orthogonality and Block Transforms. Multirate Signal Processing Fundamentals. Time-Frequency analysis of signals. Filter Bank (Subband) Theory. Multiresolution signal theory. STFT and Wavelet Transforms. Design and applications.

iii. Statistical decision Theory (relevant course: ECE 777)
Text: L. Scharf, *Statistical Signal Processing*; and S. Kay, *Statistical Signal Processing*
Sufficiency, MVUB estimators, binary hypothesis, the Neyman-Pearson detector, detection with multiple observations, detection of signals with unknown parameters, the CFAR receiver, Bayes detectors, min-max tests.

II.C Microwaves Track

i. Wave Propagation (relevant course: ECE 622)

ii. Microwave Engineering (relevant course: ECE630)
Text: Guillermo Gonzalez, *Microwave Transistor Amplifiers-Analysis and Design*," 2nd ed.,Prentice-Hall, Inc., 1997; and David Pozar, *Microwave Engineering*, 2nd ed., John Wiley & Sons, Inc., 1998.
Theory of uniform waveguides; transmission line theory in the frequency domain and the Smith chart; scattering parameters; passive components: e.g., directional couplers, hybrid junctions, power dividers; matching networks: ell networks, single stub tuning; microwave transistor amplifier design, e.g., power gain, stability, noise

iii. Antenna Theory (relevant course: ECE 632)
Text: Warren Stutzman, Gary Thiele, Antenna Theory and Design," 2nd ed., John Wiley & Sons, Inc. 1998; and Constantine Balanis, Antenna Theory-Analysis and Design, 2nd ed., John Wiley & Sons, Inc., 1997.
Fundamentals of electromagnetic field theory, vector magnetic potential, free space Green's function; far field approximation; antenna fundamentals and characterization, radiation pattern radiation intensity, directive gain, antenna beam solid angle, power gain, effective height, antenna impedance, radiation efficiency; polarization; elementary antenna types (dipoles, loops, etc.); impedance mismatch and polarization mismatch; antennas in communication links and radar; antenna arrays; wire antenna; broadband antennas.

2) Computer Architecture and Systems (CAS) Area

The student has to pass the written Ph.D. Qualifying Examination comprised of Part I and Part II.

This exam is based on recommended subjects/topics in the area of Computer Architecture and Systems (the topics as well as pointers for the students in terms of books, references, and courses that cover those subjects are provided as follows).

PART I

Exam duration is 3 hours. The student must answer 3 out of 5 problems.

Topics may be covered in ECE 658, ECE 690, EE 251, CoE 353, ECE 684, ECE 689.

PART II

Exam duration is 3 hours. The student must answer 3 out of 5 problems.

Topics may be covered in ECE 658, ECE 690, EE 251, CoE 353, ECE 684, ECE 689.

Digital Integrated Circuits:

- Analysis and design of digital integrated circuits. SPICE models.
- Basic building blocks and dependence on circuit parameters such as propagation delay; noise margin; fan-out; and fan-in.
- Power dissipation for circuits of different CMOS logic families.
- Subsystem designs in combinational and sequential logic.
- Memory Systems and
- Fundamentals of Layout design and parameter extraction.

Relevant Course: ECE 658

Suggested books:

1. Weste and Eshraghian; Principles of CMOS VLSI Design, 2nd Ed., Addison-Wesley Publishing Co. 1993.
2. K. Roy and S.C. Prasad, Low-Power CMOS VLSI Circuit Design, Wiley-Interscience, 2000.
3. Amar Mukherjee; Introduction to nMOS & VLSI System Design; Prentice-Hall, 1986.
4. Weste and Harris, "CMOS VLSI Design", 3rd edition, Addison Wesley Publishing Co. 2005

Advanced Computer Architecture:

- Program Properties
- Processor performance
- Tomasulo’s algorithm for dynamic scheduling
- Static and dynamic scheduling
- Branch prediction
- Program Partitioning/Scheduling
- Program Flow Mechanisms
- Parallel Computer Models
- Interconnection Networks, Performance Metrics
- Speedup Performance Laws (Amdahl's and Gustafson's Laws)
- Scalability Analysis
- Processors: CISC, RISC, Superscalar, VLIW, Vector, multicores

- Memory Hierarchy
- Virtual Memory Technology
- Cache Memory Technology
- Shared Memory for Parallel Computers
- Pipelining
- Superscaling
- Superpipelining

Relevant Course: ECE 690

Suggested book**:** J. L. Hennessy and D. A. Patterson, “Computer Architecture: A Quantitative Approach”, Morgan Kaufmann, 4th edition, 2007.

Digital Design:

- Number systems: binary, octal, hexadecimal, general base numbers, fixed point (1's complement and 2's complement), floating point numbers.
- Digital circuits: gates, switching algebra, combinational circuit analysis and syntesis, logic circuit minimization (Karnaugh maps), static hazards (detection and elimination).
- Design with MSI logic: decoders, multiplexors, comparators, address subtractors, PLAs, PLDs, GALs, FPGAs.
- Sequential logic design: latches and flip flops, SR, D, JK, T, master-slave, edge-triggered, state table, state assignment, synthesis problems (from word description), synchronous and asynchronous design, flow tables, races, state minimization.
- Special circuits: counters, shift registers, serial-parallel conversion.
- Sequential logic design with PLDs: sequential GALs, sequential PLDs, state machine design.
- Memory: Random access, read-only, static and dynamic RAM.

Relevant Course: EE251

Suggested book:

J. Wakerly, “Digital Design Principles & Practices”, Prentice Hall, 2000. (or 2002 edition) .

Computer Organization:

- ALU Design: Data routing within and outside of the ALU; Implementation of arithmetic and logic instructions; Generation of ALU internal control signals
- CPU Design: CPU organization; RTL specification of CPU and system functions; Data routing within the CPU; Hardwired and microsequencer control unit design; Microprogramming; Microsequencer next address generation; Microcode formats and design
- Pipeline and Vector Processing: Arithmetic pipelines - design and data routing; Instruction pipelines; SIMD architectures and algorithms; Vector architectures
- Computer Arithmetic: Arithmetic algorithms for integer, signed-magnitude, signed-2's complement, BCD, and floating point numeric formats; Arithmetic hardware
- I/O Organization: I/O interfacing; Asynchronous data transfer; Interrupts - prioritization, hardware, and software; Direct Memory Access - hardware and control software; Serial communications
- Memory Systems: Hierarchical memory organization; Associative memory - design and deployment; Cache memory - mapping strategies, system interfacing, replacement strategies, hit ratio, reading/writing data, initialization; Virtual memory - mapping hardware and methodologies, page replacement

Relevant Course: CoE353

Suggested book: "Computer Systems Organization and Architecture," by John D. Carpinelli, Addison-Wesley, 2001.

Microprocessors:

In the Microprocessor portion of the qualifying exam the candidates are expected to demonstrate mastery of both the software and hardware aspects of Motorola 68000 microprocessor as well as a general understanding of microprocessor principles. The main topics are:

- The bus structure of the 68000 microprocessor.
- The instruction set of the 68000 microprocessor including writing of short programs for various tasks. They have to be familiar with looping, stack use and subroutine calls. The employment of the LINK and UNLK instructions. The significance of ASCII, BCD, hexadecimal and binary data.
- The exception processing structure of the 68000 microprocessor. The distinction between supervisor and user mode. Privileged instructions.
- Hardware aspects of interfacing to the 68000 microprocessor. Bus buffering, memory accessing, timing diagrams and the use of the various control signals such as UDS*, LDS*, AS* and R/W*.
- Partial (non-unique) address decoding, designing memory address decoders, designing with available memory chips and generating DTACK*.
- Memory mapped I/0.

Relevant Course: ECE684
Suggested books:
The 68000 Microprocessor, Hardware and Software Principles and Applications, by James Antonakos, 5th Edition, Prentice Hall, 2004.

Computer Arithmetic:

- Number systems.
- Limits of fast arithmetic.
- Fixed point addition and subtraction.
- Floating point addition and subtraction.
- Residue numbers and its arithmetic.
- Fast multiplication.
- Fast division
- Elementary functions.
- Pipelined arithmetic.

Relevant Course: ECE689
Suggested book: I. Koren, Computer Arithmetic Algorithms, 2nd Edition, A. K. Peters, Ltd. 2002

3) <u>Computer Networking (CN) Area</u>

Structure Overview: Each student must select a Doctoral Study Area ("Area"). The student has to pass the written Ph.D. Qualifying Examination comprised of Part I and Part II.

This exam is based on recommended subjects/topics in the area of Computer Networking (the topics as well as pointers for the students in terms of books, references, and courses that cover those subjects are provided as follows).

PART I

Exam duration is 3 hours. The student must answer 5 out of 8 problems.

The problems will come from a set of topics selected from the courses: ECE673, ECE637, ECE683, with the following structure: 3 problems from ECE673, 2 problems from ECE637, and 3 problems from ECE683.

PART II

Exam duration is 3 hours. The student must answer 5 out of 8 problems.

The problems will come from a set of topics selected from the courses: ECE783,ECE645, ECE637, ECE683, ECE681, ECE639 with the following structure: 2 problems from ECE783, 2 problems from ECE645, 3 problems from ECE639/ECE681, and 1 question from ECE637.

Topics/subjects:

Internet Engineering and Design
- Network Interface Layer (Ethernet, IEEE 802.3, 802.4, 802.5, SLIP, PPP)
- IP addressing and Subnetting
- Internet Protocol Suite - Internet Protocol (IP); Address Resolution Protocol (ARP) and Reverse Address Resolution Protocol (RARP); Internet Control Message Protocol (ICMP)
- Internetworking Design: Bridges and Spanning Tree Algorithm; Routers and Routing Algorithms (Distance Vector, Link State, OSPF, RIP), Hierarchical Routing in Internet; Troubleshooting methodologies
- 5.Transport Layer Protocols in Internet
- Design and Performance Issues: Fragmentation/Reassembly; Flow and Error Control Mechanisms
- Real-Time Traffic Support and Flow in Internet: Design of IPv6; Reservation Schemes
- Relevant Course: ECE 637

Suggested References:
1. Behrouz A. Forouzan, "TCP/IP Protocol Suite," Third Edition, McGrawHill.
2. Interconnections: Bridges and Routers, by R. Perlman (Addison Wesley)

Principles of Broadband Networks
- ATM basics
- Admission Control (Chapters 3 & 4, of Integrated Broadband Networks by M. Schwartz)
- Congestion Control (Chapter 6, Data Networks, Bertsekas & Gallager; Chapter , High-speed Networks, W. Stallings, 1998)
- Congestion Control in heterogeneous networks (articles)
- Traffic Models, self-similar traffic (Chapter 9, High-speed Networks, 2nd Edition, W. Stallings, 1998, & some journal papers)

- Optical networks (articles)
- Switching Principles and Architecture (J. Walrand and P. Varaiya, High-Performance Communication Networks, 2/e, Morgan Kaufmann, 2000.)
- Broadband Packet Switching Technologies, H.J. Chao, C.H. Lam, and E. Oki, Wiley, 2001.
- Traffic Scheduling
- IP/ATM Convergence

Relevant Courses: ECE 639 and ECE681
Suggested Reference: A. Leon-Garcia and I. Widjaja, Communications Networks, McGraw Hill, 2000.

Wireless Networks
1. 2nd generation cellular FDMA, TDMA, CDMA capacity analyses
2. Packet radio protocols and performance (CDPD, ALOHA, PRMA)
3. Radio resource allocation, re-use, radio capacity
4. Handoff management, hard, soft handoffs
5. Location management, location updating versus paging optimizations
6. Mobility modeling
7. Offered traffic modeling

Relevant Course: ECE645
Suggested Reference:
1. T. S. Rappaport, "Wireless Communications: Principles and Practice," Prentice Hall PTR

Computer Network Design
1. Layered Architectures in Data Networks: OSI Reference Model; TCP/IP Reference Model
2. Physical and Data Link Layer
3. Queuing theory: Markov chains, Markov processes, M/M/1 and general M/M/N/K queues
4. Multiplexing
5. Routing and Graph algorithms: shortest path/paths, spanning tree, maximal flow
6. Error-correcting codes
7. Local Area Networks: Protocols and Standards; Performance Evaluation

Relevant Course: ECE 683
Suggested References:
1. “Telecommunication Networks: Protocols, Modeling and Analysis”, by Mischa Schwartz, Addison-Wesley
2. “Data and Computer Communications”, by W.Stallings, 5th Edition,Prentice Hall

Random Signal Analysis
Same topics and problems as for the AM part of the Communications Focus Area. Random Signals (ECE 673). Basic concepts in probability, pdfs of common distributions, random variables and their functions (1-D, 2-D, and m-D), (3) statistics (moments and covariance matrix) of random variables, WSS and independent random processes, properties, applications, the central limit theorem, Chebyshev inequality, ergodic theorem, LTI systems with random inputs, correlation function, power spectral density and I/O relations.
Relevant Course: ECE673
1. Leon-Garcia, *Probability and Random Processes*,
2. Papoulis, *Probability, Random Variables, and Stochastic Processes*

Computer Communications Networks (Analysis, Modeling, Performance Evaluation)
- Switching Techniques: Circuit switching, packet switching, store-and-forward switching
- Delay and Blocking Models: Multiplexing schemes; Little's Theorem; M/M/1, M/G/1, M/M/m systems; Birth-death processes; Open queueing networks, closed queueing networks; Kleinrock Independence Approximation, Jackson's Theorem, Burke's Theorem; Priority queues; Queueing modeling

- Error Detection and Correction: parity checks, error codes; Retransmission strategies;
- Flow Control and congestion control
- Routing: Bellman-Ford, Dijkstra algorithms; Ability to analyze and compare routing alternatives
- Multiaccess Communication: Slotted multiaccess, ALOHA, throughput performance; Polling models

Relevant Course: ECE783

Suggested Reference:

1. Bertsekas, Gallager, "Data Networks," Prentice Hall

4) <u>Solid State, VLSI and Electro-Optics Systems (SVE) Area</u>

The student has to pass the written Ph.D. Qualifying Examination comprised of Part I and Part II. This exam is based on recommended subjects/topics in the area of Solid State, VLSI and Electro-Optics Systems (the topics as well as pointers for the students in terms of books, references, and courses that cover those subjects are provided as follows).

PART I

Exam duration is 3 hours. The student must answer 5 out of 8 problems.

Topics mostly cover Semiconductor and Optical Devices and Microelectronic Fabrication and Processing Principles.

PART II

Exam duration is 3 hours. The student must answer 5 out of 8 problems.

Topics mostly cover Analog and Digital Integrated Circuits and Systems. Optoelectronics.

Topics:

Analog Circuits;

1. Methods of analysis and design of linear semiconductor circuits.
2. Low and high frequency device and circuit models.
3. Passive and active biasing techniques.
4. Analog I-C analysis and design, op-amp circuits and compensation.
5. Noise fundamentals: Analysis and Modeling
6. Fundamentals of Analog to Digital and D/A converters and Comparators

Relevant Course: ECE 650

Suggested References:

1. Johns and Martin, Analog Integrated Circuit Design, John Wiley, 1997.
2. Grey and Meyer, Analysis and Design of Analog Integrated Circuits, 3rd Edition, John Wiley, 1993.
3. Laker and Sansen, Design of Analog Integrated Circuits and Systems, McGraw-Hill, 1994.

Semiconductor Devices:

1. Fundamental principles of solid state materials necessary for understanding semiconductor devices such as crystal structure; energy bands; electron and hole generation, and transport phenomena (mobility); generation and recombination processes, and high field effects.
2. P-N junction diode, metal semiconductor contact, and bipolar and metal oxide semiconductor field effect transistors, including switching phenomena and circuit models.
3. Introduction to: photonic devices, light emitting diodes, semiconductor lasers, photodetectors, and solar cells; microwave devices, tunnel and IMPATT diodes, transferred electron devices, and charge-coupled devices.

Relevant Course: ECE 657

Suggested References:

1. Streetman and Banerjee, Solid State Electronic Devices, 5th Edition, Prentice Hall, 2000.
2. S.M. Sze, Physics of Semiconductor Devices, 2nd Edition, John Wiley, 1981.

Microelectronic Fabrication Principles:

1. Fundamental details of all major silicon integrated circuits fabrication steps.

2. Impurities and defects in semiconductors. Gas phase. Kinetic theory of gases. Vapor pressure and phase transitions. Vacuum science and technology.
3. Crystal growth, epitaxy (Amorphous and polycrystalline films), oxidation, diffusion, ion implantation and etching.
4. Formation of thin film structures along with techniques for defining sub-micron and nanometer structures such as PECVD, LPCVD, high and low dielectric constant materials, and metallization.
5. Photolithography, Multilevel Interconnects, Process Integration.
6. Basic processing of compound semiconductors such as Gallium Arsenide.

Relevant Course: ECE 659

Suggested References:

1. S. Wolf and R.N. Tauber, Silicon Processing for the VLSI Era, 2nd ed. Lattice Press.
2. S. A. Campbell, The Science and Engineering of Microelectronic Fabrication, Oxford University Press, 1996.
3. Sorab K. Ghandi, VLSI Fabrication Principles, 2-nd ed. John Wiley 1994.

Digital Integrated Circuits:

1. Analysis and design of digital integrated circuits. SPICE models.
2. Basic building blocks and dependence on circuit parameters such as propagation delay; noise margin; fan-out; and fan-in.
3. Power dissipation for circuits of different CMOS logic families.
4. Subsystem designs in combinational and sequential logic.
5. Memory Systems and
6. Fundamentals of Layout design and parameter extraction.

Relevant Course: ECE 658

Suggested References:

1. Weste and Eshraghian; Principles of CMOS VLSI Design, 2nd Ed., Addison-Wesley Publishing Co. 1993.
2. K. Roy and S.C. Prasad, Low-Power CMOS VLSI Circuit Design, Wiley-Interscience, 2000.
3. Amar Mukherjee; Introduction to nMOS & VLSI System Design; Prentice-Hall, 1986.

Optoelectronic Devices and Materials:

1. Optical propagation in anisotropic materials.
2. Polarization, birefringence and periodic media.
3. Concepts of electro-optics and acousto-optic devices,
4. Optical modulators and switches
5. Active filters for optical communication and optical processing.

Relevant Course: ECE 626

Suggested References:

1. A. Yariv, "Optical Electronics in Modern Communication", 5th edition, Oxford University Press, NY 1997.

5) Intelligent Systems (IS) Area

The student has to pass the written Ph.D. Qualifying Examination comprised of Part I (Fundamental) and Part II (Advanced). This exam is based on recommended subjects/topics in the area of Intelligent Systems (the topics as well as pointers for the students in terms of books, references, and courses that cover those subjects are provided as follows).

PART I (Fundamental)

Exam duration is 3 hours. The student must answer 5 out of 6 problems. Topics mostly cover continuous/discrete time transforms, differential equation (ordinary/partial), vector and state space analysis (ECE601), random variables/processes, spectral analysis, integral calculus, and linear systems with random signals (ECE673).

PART II (Advanced)

It is a 3-hour written exam in the candidate's specialization. Topics will be chosen by the area committee.