Qualifying Examination Format
ECE Doctoral Programs

Each student is required to select a minor and major area from five focus areas: 1) Communications and Signal Processing, 2) Computer Architecture and Systems, 3) Computer Networking, 4) Solid State, VLSI and Electro-Optics Systems, and 5) Intelligent Systems. The minor area requirements are satisfied by taking two courses in the corresponding minor area (the courses are defined by the corresponding focus area) and obtaining in both courses grade B or better. Each student is required to take and pass the written examination (consisting of two parts) in the selected major area.

Qualifying Examination Format
Focus Area: Communications, Signal Processing and Microwaves

Structure Overview: Each student will have to select a minor and major area. The minor area requirements will be satisfied by taking two courses in the corresponding minor area (the courses will be defined by the corresponding focus area) and obtaining in both courses grade B or better. In order to satisfy the corresponding requirements for the Communications and Signal Processing Area as a major area every student has to pass a separate written examination. This written part is based on recommended subjects/topics in the area of Communications and Signal Processing (the topics as well as pointers for the students in terms of books, references, and courses that cover those subjects are provided in the following).

Communications and Signal Processing Area as a minor area: In reference to the qualifying exams the students that have selected Communications and Signal Processing Focus Area as their minor area, in order to satisfy the corresponding requirements, have to take the following courses (and obtain grade B or better in both of them):
Two of { ECE 642, ECE 742, ECE 640, ECE 740, ECE 630, ECE 632}

Communications and Signal Processing Area as a major area: The exam for the students that take the Communications and Signal Processing Area as the major area will consist of two parts: 1 (fundamental) and 2 (advanced), as follows.

Part 1 (Fundamental): 3 hour, answer 6 out of 12 questions

- Digital Signal Processing (relevant course: ECE 640)
    - Oppenheim and Schafer, *Discrete-Time Signal Processing*
    - 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.
- Communication Systems (relevant course: ECE 642)
    - A.B. Carlson *Communication Systems.*
    - Linear CW modulation, exponential CW modulation, CW modulation systems, baseband digital transmission, multiplexing and switching, system noise calculations.
- Random Signals (relevant course: ECE 673)
    - Leon-Garcia, *Probability and Random Processes,*
    - 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.
- Electromagnetics (relevant course: ECE 620)
    - David Cheng, *Fields and Wave Electromagnetics,*" 2nd ed., Addison Wesley Publishing Co., 1989.
    - Ramo, Whinnery & Van Duzer, *Fields and Waves in Communication Electronics*, 3rd ed., John Wiley & Sons, Inc. 1993.
    - 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.

Part 2 (Advanced): 3 hours, answer 6 out of 12 questions

- Digital Communications (relevant courses: ECE 742, ECE 755)
  - Salehi and Proakis, *Communication Systems Engineering*
  - 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.
- Statistical decision Theory (relevant course: ECE 777)
  - L. Scharf, *Statistical Signal Processing*
  - 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.
- Advanced Signal Processing (relevant course: ECE 740)
  - 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.
- Microwave Engineering (relevant course: ECE630)
  - Guillermo Gonzalez, *Microwave Transistor Amplifiers-Analysis and Design*," 2nd ed., Prentice-Hall, Inc., 1997.
  - 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
- Antenna Theory (relevant course: ECE 632)
  - Warren Stutzman, Gary Thiele, Antenna Theory and Design," 2nd ed., John Wiley & Sons, Inc. 1998.
  - 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 haracterization, 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.

Qualifying Examination Format
Focus Area: Computer Architecture and Systems

Structure Overview: Each student will have to select a minor and major area. The minor area requirements will be satisfied by taking two courses in the corresponding minor area (the courses will be defined by the corresponding focus area) and obtaining in both courses grade B or better. In order to satisfy the corresponding requirements for the Computer Architecture and Systems Area as a major area every student has to pass a separate written examination. This written part 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 in the following).

Computer Architecture and Systems Area as a minor area: In reference to the qualifying exams the students that have selected Computer Architecture and Systems Focus Area as their minor area, in order to satisfy the corresponding requirements, have to take the following courses (and obtain grade B or better in both of them):
ECE 690 and one of the {ECE658 or ECE689} (the student may choose one).

- **Computer Architecture and Systems Area as a major area:** The exam for the students that take the Computer Architecture and Systems Area as the major area will consist of two 3-hour parts.

Part 1 (duration 3 hours): Students are given 5 problems and choose 3 problems to solve.
Topics may be covered in ECE 658, ECE 690, EE 251, CoE 353, ECE 684, ECE 689.

Part 2 (duration 3 hours): Students are given 5 problems and choose 3 problems to solve.
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.

Advanced Computer Architecture:
- Program Properties
- 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
- Memory Hierarchy
- Virtual Memory Technology
- Cache Memory Technology
- Shared Memory for Parallel Computers
- Pipelining
- Superscaling
- Superpipelining

Relevant Course: ECE 690

Suggested book: Advanced Computer Architecture, by K. Hwang, McGraw Hill, 1993.

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:

Digital Design Principles & Practices, by John F. Wakerly, Prentice Hall, third 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:
Requirements for the microprocessor portion of the doctoral qualifying examination as set forth by Dr. Sol Rosenstark.

In the Microprocessor portion of the qualifying exam the candidates aee 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 generatingDTACK*.
- Memory mapped I/0.

Relevant Course: ECE684
Suggested books:
The main reference at this time are chapters 1 through 9 of the book "The 68000 Microprocessor Hardware and Software Principles and Applications," by James L. Antonakos, 3rd Edition, Prentice-Hall, 1996. It is very good for learning both hardware and software topics for the Motorola 68000. It is now used in our undergraduate CoE 252 and EE 352 microprocessor courses, so our bookstore should have plenty of copies on hand. *This book can be used during the microprocessor portion of the qualifying exam.*
Another reference is "68000 Family Assembly Language," by Alan Clements, PWS Publishing Company, Boston, MA, 1994. It is an excellent reference on 68000 software aspects. It is available at most big Barnes and Noble stores. *This book definitely cannot be used during the microprocessor portion of the qualifying exam.*

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: Israel Koren, Computer Arithmetic Algorithms, Prentice Hall, 1993.

Qualifying Examination Format
Focus Area: Computer Networking

Structure Overview: Each student will have to select a minor and major area. The minor area requirements will be satisfied by taking two courses in the corresponding minor area (the courses will be defined by the corresponding focus area) and obtaining in both courses grade B or better. In order to satisfy the corresponding requirements for the Computer Networking Area as a major area every student has to pass a separate written examination. This written part 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 in the following).

Computer Networking Area as a minor area: In reference to the qualifying exams the students that have selected Computer Networking Focus Area as their minor area, in order to satisfy the corresponding requirements, have to take the following courses (and obtain grade B or better in both of them):
ECE 683 and one of the {ECE637 or ECE783} (the student may choose one)

Computer Networking Area as a major area: The exam for the students that take the Computer Networking Area as the major area will consist of two parts: 1 and 2, as follows.

Part 1 (duration 3 hours): It will consist of 8 questions (problems). Each student should answer 5 out of the 8 questions. The problems will come from a set of topics selected from the courses: ECE673, ECE637, ECE683, with the following structure: 3 questions from ECE673, 2 questions from ECE637, and 3 questions from ECE683.

Part 2 (duration 3 hours): It will consist of 8 questions (problems). Each student should answer 5 out of the 8 questions. The problems will come from a set of topics selected from the courses: ECE783, ECE645, ECE637, ECE681, ECE639 with the following structure: 2 questions from ECE783, 2 questions from ECE645, 3 questions 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
- 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. TCP/IP Illustrated, Vol. I, by W.R. Stevens (Addison Wesley)
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)

- Traffic Models, self-similar traffic (Chapter, High-speed Networks, W. Stallings, 1998, & some journal papers)
- Switching Principles and Architecture (J. Walrand and P. Varaiya, High-Performance Communication Networks, 2/e, Morgan Kaufmann, 2000.)
- Traffic Scheduling
- IP/ATM Convergence
- Optical Networks

Relevant Course: ECE 639
Suggested Reference: A. Leon-Garcia and I. Widjaja, Communications Networks, 2nd edition, McGraw Hill, 2004.

Broadband Packet Switches

- Packet switch architectures (input-queued, output-queued, internally-queued, combined queuing, single-stage, multi-stage, banyan, batcher, delta, recirculation architectures)
- Packet Classification
- Table (IP) lookup
- Packet scheduling

Relevant Course: ECE 681
Suggested Reference: H. J. Chao, H. Lam, and E. Oki, Broadband Packet Switching Technologies, Wiley Interscience, chapters 3-5, 8-11, and 13.

-

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, and general queues
4. Multiplexing
5. Circuit-switching networks
6. Peer-to-peer protocols
7. Data link control
8. Packet-switching networks
9. Routing and Graph algorithms: shortest path/paths, spanning tree, maximal flow
10. 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
3. A. Leon-Garcia and I. Widjaja, Communications Networks, 2nd edition, McGraw Hill, 2004.

Random Signal Analysis

Same topics and questions 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

Qualifying Examination Format
Focus Area: Solid State, VLSI and Electro-Optics Systems

Structure Overview: Each student will have to select a minor and major area. The minor area requirements will be satisfied by taking two courses in the corresponding minor area (the courses will be defined by the corresponding focus area) and obtaining in both courses grade B or better. In order to satisfy the corresponding requirements for the Solid State, VLSI and Electro-Optics Systems Area as a major area every student has to pass a separate written examination. This written part 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 in the following).

Solid State, VLSI and Electro-Optics Systems Area as a minor area: In reference to the qualifying exams the students that have selected Solid State, VLSI and Electro-Optics Systems Focus Area as their minor area, in order to satisfy the corresponding requirements, have to take the following courses (and obtain grade B or better in both of them):
ECE 650, and one of the {ECE657 or ECE659} (the student may choose one)

Solid State, VLSI and Electro-Optics Systems Area as a major area: The exam for the students that take the Computer Networking Area as the major area will consist of two parts: 1 and 2, as follows.

Part 1 (duration 3 hours): Students are given 8 problems and they select 5 problems to solve. Topics mostly cover Semiconductor and Optical Devices and Microelectronic Fabrication and Processing Principles.

Part 2 (duration 3 hours): Students are given 8 problems and they select 5 problems to solve. 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.

Qualifying Examination Format
Focus Area: Intelligent Systems

Structure Overview: Each student will have to select a minor and major area. The minor area requirements will be satisfied by taking two courses in the corresponding minor area (the courses will be defined by the corresponding focus area) and obtaining in both courses grade B or better. In order to satisfy the corresponding requirements for the Intelligent Systems Area as a major area every student has to pass a separate written/oral examination. This written part 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 in the following).

Intelligent Systems Area as a minor area: In reference to the qualifying exams the students that have selected Intelligent Systems Focus Area as their minor area, in order to satisfy the corresponding requirements, have to take the following courses (and obtain grade B or better in both of them):
Choose two from ECE 605, ECE610, and ECE660.

Intelligent Systems Area as a major area: The exam for the students that take the Intelligent Systems Area as the major area will consist of two parts: 1 and 2, as follows.

Part 1 (duration 3 hours): Students are given 6 problems on analysis and engineering mathematics, and they select 5 problems to solve. 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 2 (duration 3 hours): 3 hours written exam in the candidate's specialization. Topic to be chosen by the area committee. The candidate will have access to a PC and the internet.