Written Qualifying Exam Areas

Digital Signal Processing

Topics:

1. Sampling theory and aliasing
2. Continuous-time Fourier transform
3. Discrete-time Fourier transform
4. Z transform
5. Discrete-time linear, shift invariant systems
6. Stability and causality
7. Basic analog filter design (e.g. Butterworth)
8. Digital filter Design
9. Linear phase and group delay
10. Allpass systems
11. Fast Fourier Transform
12. Signal flow graphs
13. Direct Form I and II structures
14. Multirate signal processing

Textbooks:

- Oppenheim and Schafer, Discrete-time Signal Processing (3rd Edition), Prentice Hall (ISBN: 0131988425)
- Proakis and Manolakis, Digital Signal Processing (4th Edition), Prentice Hall (ISBN: 0131873741)

Courses: EE 7372 or equivalent

Communications

Topics:

1. Probability and random processes: Basic probability, random variables, expectations, moment-generating functions, transformation of random variables, random processes, Gaussian random process, stationarity (wide-sense, strictly, and cyclo- stationary processes), correlation, power spectral density, filtered noise processes, representation of band pass processes, ergodicity, MMSE (Wiener) filtering.
2. Fourier analysis and analog communication: Fourier series, Fourier transforms, time averages, amplitude modulation, phase/frequency modulation, implementation aspects, spectral characterisitcs, effect of noise on analog communication systems, SNR comparison of performance of AM, FM and PM systems.
3. Digital communication systems: A to D conversion, pulse code modulation, binary and M-ary modulation, signal space representations, optimum reception of signals, probability of error calculation, communication through Gaussian channels, Pulse Code Modulation Systems: Quantization, transmission line coding and codes.
4. Source coding and basic scalar Quantization theory.

Courses:

EE 7370, EE 7375.

Textbooks:

- J. G. Proakis, Digital Communications, 4th Edition, McGraw-Hill, 2001.
- A. Papoulis and S. U. Pillai, Probability, Random Variables and Stochastic Processes, 4th Edition, McGraw-Hill, 2002.
- B. P. Lathi, Modern Digital and Analog Communications, 3rd Edition, Oxford University Press, 1998.
- S. Haykin, Communication Systems, 4th Edition, Wiley, 2000.
- J. G. Proakis and M. Salehi, Fundamentals of Communication Systems, Preston Prentice Hall, 2005.

Electromagnetic Theory and Optics

Topics:

1. Electrostatic Problems – Capacitance

2. Magnetostatic Problems - Inductance

3. Electromagnetics (Time Varying) – Maxwell's Equations and Plane-wave Propagation

4. Review of Maxwell's equations.
   A. Differential form
   B. Integral form
   C. Boundary conditions

5. Transmission line theory.
   A. Telegraphist's equations
   B. Smith Chart

6. Plane wave propagation and reflection.
   A. Plane wave propagation
   B. Polarization
   C. Plane wave normally incident on discontinuities
   D. Plane wave obliquely incident on discontinuities
   E. Transmission line analogy

7. Waveguides with cylindrical conducting boundaries. .
   A. General formulation for guided waves
   B. Rectangular waveguides
   C. Circular waveguides
   D. General properties of guided waves

8. Special waveguide types.
   A. Dielectric slab guides
   B. Surface guides

9. Resonant cavities.
   A. Elemental concepts of cavity resonators
   B. Resonators of simple shape
   C. Energy storages, losses and Q of simple resonator

Courses: EE3330: Electromagnetic Fields and Waves

EE5330/73330: Electromagnetics: Guided Waves

Textbooks: *Engineering Electromagnetics*, W. H. Hayt, Jr., McGraw Hill

Fields and Waves in Communication Electronics, S. Ramo, J.R. Whinnery & T. Van Duzer., Wiley & Sons, Inc.

Circuits

Analog:

1. Basic MOS Device Physics (MOS small signal model and second-order effects)
2. Single-stage amplifiers and differential amplifiers
3. Current mirrors
4. Frequency responses
5. Electronic noise
6. Electronic Feedback
7. Circuit stability and frequency compensation
8. Bandgap references
9. Oscillator
10. Basics of switched-capacitor circuits
11. Basics of Phase-locked loops
12. Nonlinearity and mismatches
13. Operational amplifiers

Textbooks:

- Design of Analog CMOS Integrated Circuits, by Behzad Razavi
- Analysis and Design of Analog Integrated Circuits, by Paul R. Gray, Paul F. Husrst, Stephen H. Lewis, and Robert G. Mayer.

Digital:

1. MOS Device Physics (MOS transistor I-V curve, threshold voltage, and MOS capacitance)
2. Static Characteristics of Inverters
3. Dynamic/Transient Characteristics of Inverters
4. Combinational MOS Logic Circuits
5. Alternative Static Logic Circuits
6. Sequential MOS Logic Circuits
7. Dynamic MOS Logic Circuits
8. Semiconductor Memory
9. Interconnect, Timing, and I/O Circuits

Textbooks:

- CMOS Digital Integrated Circuits: Analysis and Design, 3rd edition by Sung-Mo Kang, and Yusuf Leblebici,
- Digital Integrated Circuits by Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic

Courses for circuits area: EE7356, EE7321, EE8355