SYLLABUS

FOR THE

DOCTORAL QUALIFYING EXAM

Ph.D/D.Eng. Electrical Engineering Option

These are the general topics for the appropriate subjects in the Qualifying Exam. If you have specific questions, it will be best to contact the appropriate Instructor if you have any questions.

Updated January 2020
DOCTORAL QUALIFYING EXAMINATION SYLLABUS

EE GROUP 1: CIRCUITS AND DEVIES

- CIRCUITS AND NETWORKS
  - Basic Circuit Laws: Ohm's Law, Kirchhoff's Laws
  - Thevenin's and Norton's theorems
  - Mesh and nodal analysis
  - Superposition theorems
  - Maximum power transfer theorems
  - Driving-point impedances
  - Dependent sources
  - Natural and forced responses
  - Phasors and sinusoidal steady state response
  - Series resonance and parallel resonance
  - Two-port network parameters
  - Linear op amp circuits

- ELECTRONIC DEVICES
  - Diodes
  - Field Effect Transistors
  - Dipolar Junction Transistors
  - Single stage Amplifiers including large signal and small signal analysis
  - Frequency response of single stage Amplifiers using hybrid-Π model

- ELECTRONIC CIRCUITS
  - Design and Application of Operational Amplifiers
  - Current Sources and Current Mirrors
  - Differential Pair Amplifiers
  - Multistage Amplifier Circuits
  - Frequency Response
  - Feedback Amplifiers
  - ADC/DAC
EE GROUP 2: SYSTEMS ANALYSIS

- **SIGNS AND SYSTEMS**
  - Mean, mean square, and RMS values
  - DC, AC, and complex power in deterministic signals
  - Phasors
  - Fourier series and finite Fourier series
  - Fourier transform and discrete Fourier transform
  - The s-plane
  - Laplace transform
  - Convolution

- **Probability and Random Signals**
  - Issues of the nature and characterization of random events, with particular reference to noise and its effect on systems
  - Discrete and continuous probability
  - Random processes and the response of linear systems to random processes including noise processes
  - Applications of theory to reliability and spectral analysis, confidence intervals and confidence limits.

- **Linear Feedback Systems**
  - Step and impulse-response of linear systems
  - Convolution
  - Nyquist sampling theorem
  - Stability and Stabilization via Feedback
  - Steady-state tracking and system type
  - Routh’s stability criterion
  - PID control
  - Lead-lag compensation
  - Root-Locus design method
  - Bode-plot techniques
EE GROUP 3: Computer Logic and Programming

- LOGIC DESIGN
  ✓ Boolean algebra
  ✓ Boolean functions-standard forms and simplification including Karnaugh maps
  ✓ Analysis of combinational circuits
  ✓ Synthesis of combinational circuits - two-level circuits, multi-level circuits, and minimal realizations with
  ✓ various types of gates and certain modular circuits
  ✓ Modular combinational circuits: Decoders, encoders, multiplexers, and demultiplexers
  ✓ Latches and flip-flops
  ✓ Analysis of synchronous sequential circuits (finite state machines) – Moore model and Mealy model
  ✓ Synthesis of synchronous sequential circuits (finite state machines) – Moore model and Mealy model

- ASSEMBLY LANGUAGE AND MICROPROCESSORS
  ✓ Two's complement arithmetics
  ✓ Addressing modes and address generation
  ✓ Data organization (endianness and alignment)
  ✓ Stacks
  ✓ Basic instructions (data transfer, arithmetic, logic, shift, rotation)
  ✓ Conditional and unconditional branches
  ✓ Subroutines
  ✓ Protected-mode memory management (address translation, multitasking and protection)
  ✓ System clock and bus cycles
  ✓ Hardware organization of memory address space
  ✓ Memory interface circuitry and subsystem design
  ✓ Input and output interfacing
  ✓ Exceptions and interrupts

- APPLICATION PROGRAMMING
  ✓ Basic C concepts: constants, variables, operators, expressions and assignment statements
  ✓ Console input and output (scanf() and printf())
  ✓ Decisions and selection: if and switch statements
  ✓ Repetition: while, do-while, and for loops
  ✓ Functions: calling functions and writing function prototypes/definitions
  ✓ One and two-dimensional arrays
  ✓ Character strings
  ✓ C-style structures
  ✓ File input / output
EE GROUP 4: ELECTROMAGNETICS AND POWER

- ELECTROMAGNETICS FIELDS
  - Gauss's Law
  - Poisson's and Laplace's Equations
  - Biot-Savart's Law
  - Boundary Conditions
  - Faraday's Law
  - Maxwell's Equations

- ELECTROMAGNETIC WAVES
  - Plane Waves
  - Maxwell’s Equations
  - Skin Effect
  - Transmission Lines
  - Boundary Conditions
  - Reflection and Transmission
  - Lossy Media

- ELECTROMECHANICS
  - Magnetics and magnetic circuits
  - Transformers
  - Electromagnetic force and voltage induction
  - Synchronous machines
  - Induction machines
  - DC machines
EE GROUP 5: MATHEMATICS

- VECTOR CALCULUS AND DIFFERENTIAL EQUATIONS
  - Vector algebra
  - Orthogonal Coordinate System
  - Curl, divergence and gradient operations
  - Integrals of scalar and vector fields
  - Stoke's theorem
  - Divergence Theorem
  - Solution of linear homogeneous differential equations
  - Complementary function and particular integral
  - Series solution of D.E. and Forbenius method
  - Bessel's and Legendre's differential equations
  - Hermite and Laguerre polynomials
  - Dirichlet's and Neumann's problems
  - Separation of variables method of solving partial D.E.

- Complex Variables and Linear Algebra
  - Complex algebra, Argand plane, integer and fractional powers, set theory, functions, limits and continuity, analyticity, harmonic functions, basic transcendental functions.
  - Integration in the complex plane, contour integration, path independence, Cauchy-Goursat Theorem, Cauchy Integral formula
  - Infinite series, power, Taylor and Laurent series
  - Classification of singularities, evaluation of residues, evaluation of real integrals with residue calculus, evaluation of
  - Fourier Transform type integrals with residues, inversion of Laplace transforms with residues

Linear Algebra:

  - Elementary algebraic operations, properties of determinants, inversion of a matrix, orthogonal matrices
  - Simultaneous equations: Gaussian elimination, Cramer's rule, linear dependence of vectors
  - Eigenvalues, eigenvectors, modal matrix, spectral matrix, diagonalization of a matrix