POLYTECHNIC UNIVERSITY

Department of Electrical and Computer Engineering

Recommended Topic Coverage
For the 2007 Ph.D. Qualifying Examination

COMMUNICATIONS

- Random variables and functions of random variables; probability density functions and conditional distributions; central limit theorem.

- Random processes and stationary; Poission, Wiener and Markov processes; Erogodicity;stochastic input to linear and non-linear systems; power spectral density and spectral factorization; matched filter; K.L. expansion;white noise;discrete time processes.

- Detection of deterministic and random signals in noise; Neymann-Pearson Lemma and minimax procedure.

- Estimation of deterministic and random parameters; mean square estimation , MAP,MLE;Cramer-Rao bound; Wiener and Kalaman filtering.

- Analog and Digital Modulation Techniques: AM, DSB, SSB, VSB, FM, PM, PSK, ASK, FSK and PCM; noise analysis in AM, FM and PCM; quantization;intersymbol interference and pulse shapping;matched filter for white and color noise; optimum receiver design;characterization of M-ary modulation schemes and probability of error calculation; linear block codes,convolutional codes and viterbi decoding algorithm, hard versus soft decision decoding.

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Recommended Topic Coverage
For the 2006 Ph.D Qualifying Examination

COMPUTER ENGINEERING AND NETWORKING

- **Computer Algorithms**

  - Sorting and selection: various Algorithms and lower bounds. String matching.

  - Graph algorithms: Connectivity, shortest paths, minimum spanning trees, network flow, matching. Dynamic programming and divide-and Conquer.

- **High-Speed Networking and Switching:**

  - Quality of service control: traffic shaping, buffer management, Packet scheduling and congestion control
  - Packet switch architecture design and analysis

VLSI AND ADVANCED HARDWARE DESIGN:

- CMOS circuit design, static and dynamic circuit design, and mixed circuit (analog/digital) design, standard cells and gate arrays, data path, memory and
- Control logic design and clocking schemes.VHDL based modeling.
- High speed architectures with application to crypto architectures

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NETWORKS

- Probability; Queuing Theory- Poisson process, M/M/1 queues, Little's Formula; birth death processes, the M/G/1 queue, priority systems,pollingsystems; open and closed queuing networks, Jackson networks; applications in circuit and packet- switched networks; multi-access communications – polling; ALOHA, CSMA , CSMA/CD (802.3 LANS);splitting algorithms.

- Unconstrained optimization in finite dimensional spaces (necessary and sufficient conditions for extrema, convexity); constrained optimization in finite dimensional spaces (necessary and sufficient conditions under equality and inequality constraints; Lagrange multipliers, Kuhn-Tucker conditions): linear programming (the simplex method, duality); dynamic programming (principle of optimality, applications).

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ELECTROMAGNETICS

- Electro and Magneto Statics: Gauss's law; potentials; conservative fields; divergence; Laplace and Poisson equations; capacitance; Ampere's and Biot-Savart laws, curl , inductance.

- Transmission Lines: pulse propagation, sinusoidal waves, transmission line concepts for solution of wave problems.

- Electrodynamics: Maxwell's equations; boundaryu conditions, power and energy.

- Propagation: plane waves, reflection and refraction , total internal reflection, Conducting media, metallic and dielectric waveguides.

- Radiation: retarded vector potential, electric and magnetic dipoles ,far field Approximations, thin wire antennas, and arrays of dipoles.

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SIGNAL PROCESSING

- Signal Representation: continuous time – Fourier and Laplace transforms; discrete time Fourier, Z-transforms, DFT, FFT; digital simulation of analog systems; Poisson Sum (continuous and discrete) relationships.

- Operations on Signals: transfer functions, derivations and analysis; stability; filter structures, topology; quantization effects; filter analysis and design, FIR, IIR ideal filters , all-pass, linear phase, etc; s to Z transformations(e.g. Bilinear).

- Sampling Theorems (time and frequency): analog to digital; digital to digital (decimation); interpolation: digital to analog and digital to digital; aliasing effects.

- Analysis of continuous and Discrete Time Systems: differential and difference equations; forced and free responses, transient and steady-state responses; frequency responses, pole-zero plots; convolution.

- Random variables and functions of random variables; Probability density functions and conditional distributions; continuous and discrete-time stationary random processes; power spectral density and spectral factorization; Linear systems with stochastic inputs; Correlation functions.

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CONTROLS

- The laplace transform and inverse transform, properties and applications ; the Z-transform and inverse transform ,properties and applications; time domain analysis for analog and discrete systems; elementary functions (unit step, impulse and delta); Impulse , step and delta response of linear systems; responses of linear systems to arbitrary inputs (convolution and superposition).

- Basic concepts of feedback, sensitivity reduction; transfer functions, block diagrams signal flow graphs; modeling of physical systems (transfer functions and state equations of electrical and mechanical systems); transient and frequency response of systems; steady state accuracy; root locus methods for analysis and design; frequency domain analysis (Bode and Nyquist plots); frequency domain design(PID, lead, lag, and lead-lag controllers).

- Solution of the state dynamic equations (state transition matrix, impulse and delta response matrices); controllability and observability; stability definitions and criteria (Nyquist, Routh, Jury tests).

- System modeling and linearization, stability, hidden modes, the single loop feedback design problem; pole placement, observer, Separation Principle, LQR design.

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POWER/POWER ELECTRONICS

- Networks- Admittance/Impedance Matrices: Basic properties, inversion, node elimination; per unit representation; control of voltage magnitudes, watts and VARs; Load Flow: algorithms, interpretation of results; transmission line inductance and capacitance.

- Electrical Machines: translation of load torque-speed characteristic to motor shaft; basic speed control of d.c and a.c. motors; braking modes of d.c. and a.c. machines ;motor power selection.

- Power Electronics: analysis of static converter systems such As: dc/dc, SMPS, ac/dc and dc/ac converters.

- Electric Drives: translation of load performance characteristic to the motor shaft; construction of a load diagram; four quadrant operation; electrical braking; speed control of motors.