ELECTRONIC AND COMMUNICATIONS ENGINEERING DEPARTMENT

Syllabus for Written Test to Ph. D Programme, July 2017.

Group A: (30 Marks: MCQ)

1) Probability and Statistics:

Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson,Normal and Binomial distributions.

2) Discrete Mathematics:

Basic operations on sets, cartesian products, disjoint union (sum), andpower sets. Different types of relations, their compositions and inverses. Different types of functions, their compositions and inverses. Complete partial ordering, chain, lattice. complete, distributive, modular, andcomplemented lattices. Boolean and pseudo booleanlattices.Algebraic structures with one binary operation – semigroup, monoid and group.Cosets, Lagrange's theorem, normal subgroup, homomorphicsubgroup.Congruence relation and quotient structures.Error correcting code.Algebric structures with two binary operations- ring, integral domain, and field. Boolean algebra and boolean ring.

3) Logical Reasoning, Data Analysis & Interpretation and Verbal Ability:

Number Sequence Completion, Pattern Completion, Sets based on grouping and patterns, Seating Arrangement problems, Circular Arrangements, Relational problems, Selection and Conditionals, Mapping and best routes, Miscellaneous sets consisting of formal logic, testing, sports events and other critical reasoning, Data Analysis, Data Interpretation, Data Sufficiency, Reading Comprehension, Verbal Logic, Vocabulary, Grammar Correction.

Group B: (40 Marks: MCQ)

This section will cover fundamentals from B. Tech Syllabus in Electronic and Communications Engineering.

Group C: (30 Marks: Descriptive)

Candidate is required to answer one of the groups. However, his/her selection may not be limited to that specialization only.

1. Adaptive Signal Processing & Wireless Communications

Discrete random processes: Random variables, random processes, filtered random processes. Ensemble averages, correlation, covariance, power spectrum, cross power spectrum.Stationarity. Ergodicity, time averages, Wiener-Kinchin theorem. White noise and Gaussian processes.

Review of Signals and Systems, Sampling and data reconstruction processes. Upsampling and downsampling. Z transforms. Discrete linear systems. Frequency domain design of digital filters. Discrete Fourier transform and FFT algorithms. High speed convolution and its application to digital filtering. Multirate signal processing.

Matched Filter, Error Rate due to Noise. Inter symbol Interference, Nyquist's Criterion, Optimum Linear Receiver. Geometric Representation of Signals. Coherent Detection of Signals in Noise, Probability of Error. Coherent Digital Modulation Schemes: MPSK, MFSK, MQAM; Error Analysis. Non-coherent FSK, Differential PSK. Comparison of Digital Modulation Schemes, Bandwidth Efficiency.

2. Low Power VLSI

Fundamentals of MOS Structures & Transistor Theory

Introduction to Band theory, effective mass, Fermi level, energy diagrams, MOS structure, MOS capacitor, physical and electrical behavior with gate bias, (CV plots).NMOS transistor, Physical structure of MOS transistor, MOS transistor under static conditions, secondary effects.Models for MOS transistor, Process variation, Technology Scaling.

CMOS Inverter

CMOS inverter, Static and Dynamic behavior of CMOS inverter, Power, Energy and Energy-Delay, Technology Scaling and Impact on inverter metrics.

Combinational & Sequential Logic Designs in CMOS

Static CMOS design, Dynamic CMOS Design, Static latches and registers, Dynamic latches and registers, Pipelining.

Designing Building Blocks

Adders, Multipliers, Shifters, Power and Speed Trade-Off in Datapath Structure, Introduction, Memory Core, Memory Peripheral Circuitry, Memory Reliability and Yield, Power Dissipation in Memories.

3. VLSI

Numbers and Arithmetic. Signed-magnitude representation. Complement representations. Redundancy in computer arithmetic, Digit sets and digit-set conversions, Generalized signed-digit numbers, Carry-free addition algorithms, Residue Number systems.

Basic Addition and Counting: Bit-serial and ripple-carry adders, Conditions and exceptions, Analysis of carry propagation, Carry completion detection, Addition of a constant: counters, Manchester carry chains and adders. Multi-Operand Adder.

Unrolling the carry recurrence, Carry-lookahead adder design, Carry determination as prefix computation, Alternative parallel prefix networks, VLSI implementation aspects Variations in fast adders: Simple carry-skip adders Carry-select adders, Conditional-sum adder, Hybrid designs and optimizations, Modular two-operand adders.

Shift/add multiplication algorithms, Programmed multiplication, Basic hardware multipliers, Multiplication of signed numbers, Multiplication by constants, Preview of fast multipliers.

Radix-4 multiplication, Modified Booth's recoding, Using carry-save adders, Radix-8 and radix-16 multipliers, Multibeat multipliers, VLSI complexity issues.

Full-tree multipliers, Alternative reduction trees, Tree multipliers for signed numbers, Partial-tree and truncated multipliers, Array multipliers, Pipelined tree and array multipliers.

Shift/subtract division algorithms, Programmed division, Restoring hardware dividers, Nonrestoring and signed division, Division by constants, Radix-2 SRT division.Elementary functions implementations.

4. Speech and Signal Processing

Probability and random variables: The meaning of probability, the axioms of probability, repeated trials, probability distribution functions - binomial, Poisson, exponential and normal;Joint and conditional probability; the concept of a random variable, functions of one random variable and two random variables. Random processes: stationarity, correlation, covariance, power spectrum, cross power spectrum.

Continuous-time signals: Fourier series and Fourier transform representations, sampling theorem and applications; Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, interpolation of discrete-time signals; LTI systems: definitionand properties, causality, stability, impulse response, convolution, poles and zeros, paralleland cascade structure, frequency response, group delay, phase delay, digital filter design techniques.

5. VLSI Architectures for Multimedia and Signal Processing

Digital System Design
Basic of Digital Design: Introduction to digital system, number representation, fixed point arithmetic, floating point arithmetic, K-Map optimization, design of Combinational circuits like adders, Multiplexers, encoder, decoders, various Flip-Flops, counters, shift registers, PALS, PLA, CPLD, Memory design, Timing characteristics, Finite State Machines. Synchronous and Asynchronous System design, ASIC and FPGA Design, examples on RTL programming

Computer Architecture and Embedded systems
Evolution of computers. Instruction Set Architecture, Processor Design: Data path, functional unit design, Control Unit Design. Memory Organization. Input-Output Organization. Pipelining, Parallel processing, RISC vs. CISC processors. Embedded microprocessors, micro-controllers (8051), embedded memory and I/O devices, component interfaces, embedded software C programming.

Signal Processing and Multimedia Algorithms
Basics of signal and systems, Z transforms, DFT, FFT, DCT, design of FIR filters and IIR filters, linear phase filters Applications of DSP, Image and Video compression

6. MEMS and Microsystems:

Introduction to MEMS and Microsystems, Working Principles of MEMS and Microsystems, Introduction to Microsensors and Microactuators, Sensing techniques for MEMS:

Piezoresistive, Piezoelectric, Capacitive and Optical sensing methods, Microactuation techniques for MEMS: Actuation methods using Thermal forces, Piezoelectric crystals and Electrostatic forces, Examples of MEMS based Microsensors and Microactuators.Typical MEMS and Microsystems Products and Applications of MEMS,

Materials and Fabrication Processes for MEMS and Microsystems: Substrates and Wafers, Active Substrate Materials, Silicon as a Substrate Material, Silicon Compounds, Gallium Arsenide, Quartz, Piezoelectric Crystals, Polymers, Packaging Materials, Fabrication processes: Photolithography, Diffusion, Ion Implantation, Oxidation, Chemical Vapor Deposition, Physical Vapor Deposition Sputtering, Deposition by Epitaxy, Dry and Wet Etching Techniques, Micromachining processes - Bulk and Surface Micromachining, LIGA Process.

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