

## Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

(Only for the Courses relating to Research Domains for both Full Time & Sponsored Part Time)

Department: EC

### 1) Research/Specialization Group: 1

(Name of the Group) Micro Electronics

**Course Code & Course Name: Digital VLSI Circuits (EC 503), LOW POWER VLSI DESIGN (EC518)**

**Syllabus Content :** Physics of power dissipation in MOSFET devices, power dissipation in cmos, Power estimation using the input vector compaction, power dissipation in domino cmos, high level power estimation, Information theory based approaches, Behavioral Level Transforms, Logic Level Optimization for Low power, Circuit Design style, Leakage current in deep submicrometer transistors, Deep submicrometer device design issues, Key to minimizing SCE, Organization of a static RAM, MOS Static RAM Memory cell, Energy dissipation in transistor channel using an RC model, hot carrier effect, sub threshold conduction, Static CMOS inverter, performance of CMOS inverter, power consumption in CMOS logic gates, Domino CMOS logic, NPCMOS-logic style, static SR flip flop, Dynamic latches and registers, Addition/Subtraction, Comparators, Zero/One Detectors

### 2) Research/Specialization Group: 2

**Research Group Name: Signal and Image Processing**

#### 1. Biomedical Image Processing:

Review of basic signals, systems and signal space: review of 1-D signals and systems, review of random signals, multi-dimensional signals. Signal representation: Transform theory and methods.

Various Medical images: X-ray and Computed Tomography (CT) imaging, Magnetic Resonance Imaging (MRI) Ultrasonic Imaging, Microscopic Imaging, Objectives of biomedical image analysis, and Difficulties in biomedical image acquisition and analysis. Gray scale thresholding, Contrast manipulation, histogram equalization, Laplacian derivatives, rank operators --textural analysis, Homomorphic filtering, Edge Detection, Optimal thresholding, Region-based segmentation (splitting and merging), K-means clustering based segmentation, Fuzzy based segmentation

Probability Distributions: Binary variable, multinomial variables, The Gaussian Distribution, The exponential family, Nonparametric methods. Neural Networks: Feed-forward Network Functions, Network Training, Error Backpropagation, Regularization in Neural Networks, Bayesian Neural Networks, Support vector machines (SVM), Mixture Models, EM algorithm, K-means Clustering, Mixtures of Gaussians, Principal Component Analysis.

Signal detection and estimation theory: Neyman-Pearson decision rules, likelihood ratio test (LRT), generalized matched filter, Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound

**Course Code & Course Name:** Concepts of Electronics and Communication (EC 701), Medical Image Analysis (EC 533), Machine Learning for Communications and signal processing (EC 546), Signal Detection and Estimation Theory (EC 548)

### 3) Research/Specialization Group: 3

**(Name of the Group): RF Microwave and Communication**

#### 1. Communication:

Wireless communications and diversity: Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless communications, BER Performance Improvement with diversity, Types of Diversity – Frequency, Time, Space. Broadband wireless channel modeling: WSSUS Channel Modeling, RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum, Impact of Doppler Fading. Cellular communications: Introduction to Cellular Communications, Frequency reuse, multiple Access Technologies, Cellular Processes - Call Setup, Handover etc. MIMO: Introduction to MIMO, MIMO Channel Capacity, MIMO Spatial Multiplexing, MIMO Diversity, MIMO, OFDM. Neural Networks: Feed-forward Network Functions, Network Training, Error Backpropagation, The Hessian Matrix, Regularization in Neural Networks, Bayesian Neural Networks. Statistical Decision Theory: Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio test (LRT), receiver operating characteristics, composite hypothesis testing, locally optimum tests, generalized LRT. Estimation of Signal Parameters: Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, maximum likelihood estimation, minimum mean square error estimation, maximum a posteriori estimation.

**Course Code & Course Name:** Concepts of Electronics and Communication (EC 701), wireless and mobile communication (EC 527), Machine Learning for Communications and signal processing (EC 546), Signal Detection and Estimation Theory (EC548)

#### 2. Microwave:

Microwave Frequency bands, Applications of Microwaves: Civil and Military, Medical, EMI/ EMC. Rectangular waveguide, Concept of Mode, Characteristics of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission, Field analysis of transmission line, Coaxial Line, Circular waveguide, Stripline, Microstrip Line, CPW Line, Equivalent Voltages and currents for non-TEM lines, Network parameters for microwave Circuits, Scattering Parameters.

Review of Maxwell's Equation; Condition of radiation of electromagnetic waves and introduction to Antenna; Vector Potential and Retarded Vector Potential; Radiation fields of a Hertzian dipole (electric); Duality Principle, Radiation fields due to short magnetic dipole. Antenna Characteristics: Radiation Pattern, Beam Width; Radiation Resistance and efficiency; Directivity and Gain, Impedance, VSWR, Polarization; Effective height and Receive Aperture; Noise Temperature of Antenna. Radiation fields and Characteristics of  $\lambda/2$  dipole; discussion on  $\lambda/4$  monopole antenna; Current distribution and Radiation patterns of center-fed dipoles of length  $\lambda$ ,  $3\lambda/2$  and  $2\lambda$ . Horizontal and Vertical antennas over a plane ground, design and analysis of Microstrip Patch Antenna.

Waveguide, boundary conditions, maxwell equations, characteristics of modes TE, TM, TEM, cavity model, basic parameters of antenna, filter, radiation pattern, polarization, RF instruments like VNA, SA, SG, Transmission line, couplers, Sparameters, Various architecture of passive components, Power feeding techniques, wireless power transfer

**Course Code & Course Name:** Microwave Engineering (EC 561), Antenna Theory and Propagation (EC 540)

Signatures and Names of DRC Members:

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Shubhanjan  
20/7/23

Shubhanjan  
20/7/2023

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20/7/2023

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Shubhanjan  
20/7/23

Signature of DRC Chairman (TCC)

Date 20/07/2023