RAJASTHAN TECHNICAL UNIVERSITY

SYLLABUS: M.TECH. (DIGITAL COMMUNICATION)

1MDC1 SIGNAL THEORY

Representation of deterministic signals: Orthogonal representation of signals. Dimensionality of signal spaces. Construction of orthogonal basis functions.
Random Processes: Definition and classification, stochastic integrals, Fourier transforms of random processes, stationary and non-stationary processes, correlation functions. Ergodicity, power spectral density, transformations of random processes by linear systems.
Representation of random processes (via sampling, K-L expansion and narrow band representations), special random processes :white Gaussian noise, Wiener-Levy process, Poisson process, shot-noise process, Markov process.
Optimum Filtering: Matched filters for deterministic signals in white and colored Gaussian noise. Wiener filters for random signals in white and colored Gaussian noise.

1MDC2 DIGITAL COMMUNICATION SYSTEM

Characterization of communication signals, signal space representation, equalisation, matched filtering, binary PSK, QPSK, FSK, QAM & M-Ary modulation techniques and their representation. Coherent & non coherent detection, carrier & symbol synchronization, bits vs symbol error probability, bandwidth efficiency, Spread spectrum modulation: Pseudo noise sequences, DS & FH spread spectrum.

1MDC3 SATELLITE COMMUNICAITON

Introduction: Orbital mechanics and launching, earth station and satellite sub systems, satellite link: design and analysis, multiplexing techniques, multiple accesses for satellite links: FDMA, TDMA CDMA & DAMA, propagation effects, DBS-TV, GPS. VSAT: Network architecture, access control protocol & link analysis

2MDC1 DIGITAL SIGNAL PROCESSING

DFT & its properties. Decimation in time and decimation in frequency FFT algorithms, discrete cosine transform.
IIR Filter design: Butterworth design, bilinear transformation. Low Pass, High Pass, Band Pass and Band Stop digital filters. Spectral transformation of IIR filters.
FIR filter design: Symmetric and antisymmetric linear phase. FIR filter by rectangular, triangular and Blackman window functions.
Finite word length effects in FIR and IIR digital filters: Quantization, round off errors and overflow errors.
Multi rate digital signal processing: Concepts, design of practical sampling rate converters, Decimators, interpolators. Polyphase decompositions.

2MDC2 INFORMATION THEORY & CODING

Shannon's fundamental coding theorems, Differential entropy & mutual information for discrete & continuous ensembles, source coding, Rate distortion theory.
Introduction to Algebra:Groups,fields,Binary field arithmatic,Basic properties of Galois field $GF(2^m)$ and vector spaces.
Channel coding & decoding: Run length limited codes, LBC, cyclic code, BCH code, convolutional code, Trellis coded modulation, Reed-Solomon code.

2MDC3 ADVANCED OPTICAL COMMUNICATION

Optical fibers: review of fundamentals, Signal distortion and attenuation, Intermodal and intramodal dispersion, dispersion flattened and dispersion compensated fibers, Profile dispersion, study of PMD.
Laser diode and photodiode, Photodetector noise analysis, Analog and Digital communication link design.
WDM, DWDM, optical couplers, Mach-Zehnder interferometer multiplexer, optical add/drop multiplexers, isolators, circulators, optical filters, tunable sources and tunable filters, arrayed waveguide grating, diffraction grating, optical amplifiers, optical integrated circuits .Characterization of optical fibers, OTDR
SONET: frame format, overhead channels, payload pointer, Virtual tributaries, multiplexing hierarchy.
SDH: Standards ,frame structure and features.
Optical switching, WDM networks,
Classification of optical sensors.Intensity modulated, phase modulated and spectrally modulated sensors.

3MDC1 MOBILE COMMUNICATION

Cellular concept. Mobile radio propagation. Co-channel interference. Diversity. Multiple access. Cellular coverage planning. Wireless networking. Wireless systems and standards. Fading channels, spreading codes, power control. WAP and other protocols for internet access. Data transmission in GSM and UMTS, TCP in wireless environment, multi-user detection and its performance analysis. Blue-tooth and other wireless networks, system comparison.
Spread spectrum concept. Basics of CDMA. Properties and generation of PN sequences. Applications of CDMA to cellular communication systems. Second and third generation CDMA systems/ standards. Multi-carrier CDMA. Synchronization and demodulation .Diversity techniques and rake receiver.

1MDC4.1 HIGH FREQUENCY ELECTRONICS

Analysis of planar transmission lines: Variational method. losses in microstrip lines, analysis & design of devices; passive circuits, impedance transformers, couplers, power dividers, filters, oscillators, mixers, switches, amplifiers (narrow band /broad band) oscillators, active & passive phase shifters.
Microstrip lines on ferrite and garnet substrate; Isolators and circulators; lumped elements in MICs
Analysis of basic transmission lines for millimeter wave frequencies. Integrated finline, image guide and its variants, non-radiative guide, H-guide and groove guide. Millimetre wave devices for generation and detection. Transitions, bends and discontinuities.
Monolithic circuit components planar transmission lines, lumped and distributed passive elements.

1MDC4.2 OPTIMIZATION TECHNIQUES

Introduction: Historical development, application to engineering problems, statement of optimization, classification of optimization, examples of optimization problems.

Linear Programming: Graphical method, simplex method, revised simplex method, Big-M method, 2-phase method, alternate optimal solutions, unbounded LPs, degeneracy and convergence, duality in linear programming, sensitivity analysis, dual simplex method, Transportation, assignment and other applications.

Non-Linear Programming: Unconstrained optimization techniques, direct search methods (Fibannoci method, golden section, quadrature and cubic interpolation) descent methods, constrained optimization, direct and indirect methods, optimization with calculm, kuhn-tucker conditions.

Dynamic Programming: Multistage decision process, principles of optimality, computational procedures in dynamic programming.

1MDC4.3 BIOMEDICAL ELECTRONICS

Brief introduction to human physiology. Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases.

Bioelectrodes and biopotential amplifiers for ECG, EMG, EEG, etc. Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrsonic and nuclear imaging.

Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects.

Telemetry – Transmission of the original through wire & wireless.

Imaging techniques – Ultrasound, CAT, X-Rays, PET, NMR, Nuclear.

Physiological effect of electric current, safety.

Cardiological Signal Processing: Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG parameters & their estimation, the use of multi scale analysis for parameters estimation of ECG waveforms, Arrhythmia analysis, monitoring, long form continuous ECG recording.

ECG data reduction technique, Direct data compression techniques, Direct ECG data compression techniques. Transformation compression techniques. Other data compression techniques. Data compression techniques, comparison.

2MDC4.1 DETECTION AND ESTIMATION THEORY

Hypothesis testing:bayes, minimax and Neyman-Pearson criteria. Types of estimates and error bounds. Parameter Estimation: Least square, generalized and recursive least square, estimator properties including error bounds and convergence, MES, ML and MAP estimators. general Gaussian problem. Detection and estimation in coloured noise. Elements of sequential and non-parametric detection. Applications to communication, radar and sonar systems.

2MDC4.2 ADAPTIVE SIGNAL PROCESSING

Adaptive filtering: Wiener filters, linear prediction, methods of steepest descent and least-squares, least mean square adaptive filters, recursive least-squares adaptive filters, frequency domain & sub-band adaptive filters, kalman filters, square root adaptive filters, order recursive adaptive filters, finite precision effects, IIR adaptive filters. Adaptive algorithms: adaptive equalization and echo cancellation. Applications of adaptive filters.

2MDC4.3 ANTENNA THEORY AND TECHNIQUES

Review of the theory of electromagnetic radiation. Introduction to various antenna types wire, loop and helical antennas, analysis using assumed current distribution.

Aperture antennas: slot, wave guide, horn, and reflector antennas. Analysis using field equivalence principle and Fourier transform methods. Linear arrays. Traveling wave & broadband antennas. Antenna measurements.

Printed antennas: Feeding methods, transmission line & cavity models, analysis and design of rectangular & circular microstrip antenna. Arrays: pattern synthesis, planar arrays, phased arrays. Active antennas and arrays.

Paraboloidal reflector antenna, different feed configurations, shaped beam antennas, lens antenna.

Antennas for biomedical applications.

Smart antennas for mobile communications.

Antenna for infrared detectors.

3MDC2.1 TELECOMMUNICATION SWITCHING & NETWORKS

Principles of circuit switching & signaling schemes, space time & space time division switching, single stage & multi stage switching network. Traffic engineering and teletraffic theory.

Markov processes representing traffic, calculation of blocking probability.

Modeling and analysis of important media access control protocols: ALOHA, slotted ALOHA,CSMA,CSMA/CD.

LAN: Ethernet, token ring, FDDI.

B-ISDN architecture, B-ISDN protocols, ATM traffic & congestion control, signaling, routing and addressing, Internetworking: switches, bridges, routers, gateways. ATM switching.

3MDC2.2 DIGITAL IMAGE PROCESSING

Human visual system and image perception, monochrome & color vision models, color representation; image sampling & quantization; 2-D systems; image transforms; image coding, stochastic models for image representation, image enhancement, restoration & reconstruction, image analysis using multi-resolution techniques.

Wavelet Transform for Image Processing: Continuous wavelet transform, discrete wavelet transform, multi-resolution analysis, image compression.

3MDC2.3 MICRO-ELECTRO-MECHANICAL-SYSTEMS (MEMS)

Micro electro mechanical system (MEMS) origins. MEMS impetus/ motivation. Material for MEMS. The toolbox: processes for micro machining. MEMS fabrication technologies. Fundamentals MEMS device physics: Actuation. Fundamental MEMS devices: The cantilever beam. Microwave MEMS applications: MEM switch design considerations. The micro-machined transmission line. MEMS-based microwave circuit and system.

1MDC5 COMMUNICAITON SYSTEM LAB

PART I : PCM AND LINK ANALYSIS

Link establishment, Noise on PCM link, Error detection, BER calculation, Error correction, TDM.

PART II : DIGITAL MODULATION & KEYING

ASK, FSK, PSK, QPSK   Modulation and Demodulation.

PART III : CDMA - DSSS

Modulation, Demodulation & BER measurement.

PART IV : SIMULATION IN MATLAB ENVIRONMENT

BPSK, QPSK, FSK Modulation & Demodulation. BER calculation.

2MDC5 MODELING & SIMULATION LAB

EXPERIMENTS USING TMS320C6XXX DSP KITS

1.   FIR Digital Filter Design

2.   IIR Digital Filter Design

3.   FFT of a given signal

4.   Plot PSD/Power Spectrum of a signal

5.   Discrete Cosine Transform

6.   Adaptive Filter Design using Standard LMS Algorithm

7.   Speech analysis using L.P.C.