## SCHEME OF TEACHING AND EXAMINATION
### M.TECH. - DIGITAL COMMUNICATION & NETWORKING

#### II SEMESTER

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching hours/week</th>
<th>Duration of Exam in Hours</th>
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<td>Practical</td>
<td>Tutorial</td>
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<td>10LDN21</td>
<td>10EC086</td>
<td>Wireless Communication</td>
<td>4</td>
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<td>10LDN22</td>
<td>10EC046</td>
<td>Linear Algebra</td>
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<td>Modern DSP</td>
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<td>10LDN24</td>
<td>10EC125</td>
<td>Protocol Engineering</td>
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<td>10ECxxx</td>
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<td>10LDN26</td>
<td>10EC921</td>
<td>Seminar / Mini-project</td>
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Project Phase-I (6 week Duration) should start between II Semester and III Semester, after availing a vacation of 2 weeks. This will be evaluated during III semester.

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<td>10LDN251</td>
<td>10EC023</td>
<td>Cryptography &amp; Network Security</td>
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<td>10LDN252</td>
<td>10EC131</td>
<td>Wireless and Mobile Networks</td>
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**ELECTIVE – II**

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<td>10LDN253</td>
<td>10EC126</td>
<td>Real Time Operating Systems</td>
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**II – SEMESTER**

### WIRELESS COMMUNICATIONS

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<td>10EC086</td>
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**Wireless channel:** physical modeling for wireless channels, input/output model of wireless channel, time and frequency response, statistical models.

**Point to point communication:** detection in rayleigh fading channel, time diversity, antenna diversity, frequency diversity, impact of channel uncertainty.

**Capacity of wireless channels:** AWGN channel capacity, resources of AWGN channel, Linear time invariant gaussian channels, capacity of fading channels.

**MIMO I** – Spatial multiplexing and channel modeling: multiplexing capability of MIMO channels, physical modeling of MIMO channels, modeling MIMO fading channels. MIMO II – Capacity and multiplexing architectures: V-BLAST, fading MIMO channel, receiver architectures, slow fading MIMO channel, D-BLAST. MIMO III – Diversity multiplexing tradeoff, universal code design.

**References Books:**

and applications”, TMGH, 2008
1. Mark Ciampa, Jorge Olenwa, “Wireless communications”,

Laboratory Experiments:

Assignment for the Laboratory work: USE NS2 SIMULATOR (available FREE on the net)
1. Use NS2 simulator to check for the transmission power in the
   Wireless network.
2. Using NS2 measure the losses in the channel.
3. Using NS2 implement the propagation model both indoor and
   Outdoor.
4. Using NS2 measure the performance analysis of different
   models.
5. Using NS2 implement the CDMA model.
6. Using NS2 measure the Latency, BW and efficiency of the
   given Wireless model.

Any other experiments can be added to supplement the theory.

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LINEAR ALGEBRA

Subject Code : 10EC046 IA Marks : 50
No. of Lecture Hours/Week : 04 Exam Hrs : 03
Total No. of Lecture Hours : 52 Exam Marks : 100

Linear Equations: Fields; system of linear equations, and its solution sets; elementary row operations and
   echelon forms; matrix operations; invertible matrices, LU-factorization.

Vector Spaces: Vector spaces; subspaces; bases and dimension; coordinates; summary of row-equivalence;
   computations concerning subspaces.

Linear Transformations: Linear transformations; algebra of linear transformations; isomorphism;
   representation of transformations by matrices; linear functionals; transpose of a linear transformation.

Canonical Forms: Characteristic values; annihilating polynomials; invariant subspaces; direct-sum
   decompositions; invariant direct sums; primary decomposition theorem; cyclic bases; Jordan canonical form.
   Iterative estimates of characteristic values.

Inner Product Spaces: Inner products; inner product spaces; orthogonal sets and projections; Gram-Schmidt
   process; QR-factorization; least-squares problems; unitary operators.

Symmetric Matrices and Quadratic Forms: Digitalization; quadratic forms; constrained optimization;
   singular value decomposition.

REFERENCE BOOKS:

2. Kenneth Hoffman and Ray Kunze, "Linear Algebra,” 2nd edition,
3. Bernard Kolman and David R. Hill, "Introductory Linear Algebra
   with Applications”, Pearson Education (Asia) Pte. Ltd, 7th edition,
   2003.

MODERN DSP
Goal of the course – Advances in Digital Signal Processing involve variable sampling rates and thus the multirate signal processing and hence their applications in communication systems and signal processing. It is intended to introduce a basic course in multirate signal processing especially meant for students of branches eligible for M Tech courses in EC related disciplines.

Review of Signals and Systems – Discrete time processing of continuous signals - Structure of a digital filter; Frequency domain analysis of a digital filter; Quantization error; Sigma and Sigma Delta Modulation. Fourier Analysis – DFT, DTFT, DFT as an estimate of the DTFT for Spectral estimation. DFT for convolution, DFT/DCT for compression, FFT. Ideal Vs non ideal filters, FIR and IIR Filters Digital Filter Implementation; Elementary Operations.

Digital Filters – State Space realization, Robust implementation of Digital Filters, Robust implementation of equi – ripple FIR digital filters

Multirate Systems and Signal Processing, Fundamentals – Problems and definitions; Upsampling and downsampling; Sampling rate conversion by a rational factor;

Multistage implementation of digital filters; Efficient implementation of multirate systems.


Maximally Decimated Filter banks – Vector spaces, Two Channel Perfect Reconstruction conditions; Design of PR filters Lattice Implementations of Orthonormal Filter Banks, Applications of Maximally Decimated filter banks to an audio signal.

Introduction to Time Frequency Expansion; The STFT; The Gabor Transform, The Wavelet Transform; The Wavelet transform; Recursive Multiresolution Decomposition.

References:

Laboratory Experiments:
I. Modern Digital Signal Processing

i. Using MATLAB

1. Question based on response of LTI systems to different inputs
A LTI system is defined by the difference equation \( y[n] = x[n] + x[n-1] + x[n-2] \).
(a) Determine the impulse response of the system and sketch it.
(b) Determine the output \( y[n] \) of the system when the input is \( x[n] = u[n] \).
(c) Determine the output of the system when the input is a complex exponential \( (Eg. \ x[n] = 2e^{j0.2\pi n}) \).

2. Question on design of simple digital filter using the relationship between pole and zeros and the frequency response of the system
Design a simple digital FIR filter with real co-efficients to remove a narrowband (i.e., sinusoidal) disturbance with frequency $F_0=50$ Hz. Let $F_s=300$ Hz be the sampling frequency.
(a) Determine the desired zeros and poles of the filter.
(b) Determine the filter coefficients with the gain $K=1$
(c) Sketch the magnitude of the frequency response.

3 **Question on simple digital filtering using the relationship between pole and zeros and the frequency response of the system**
Design an IIR filter with real co-efficients with same specifications mentioned in Q2 and repeat the steps (a) to (c).

4. **Question to understand the effect of time domain windowing**
Generate a signal with two frequencies $x(t)=3\cos(2\pi F_1 t) + 2\cos(2\pi F_2 t)$ sampled at $F_s=8$ kHz. Let $F_1=1$ kHz and $F_2=F_1+\Delta$ and the overall data length be $N=256$ points.
(a) From theory, determine the minimum value of $\Delta$ necessary to distinguish between the two frequencies.
(b) Verify this result experimentally. Using the rectangular window, look at the DFT with several values of $\Delta$ so that you verify the resolution.
(c) Repeat part (b) using a Hamming window. How did the resolution change?

5 **Comparison of DFT and DCT (in terms of energy compactness)**
Generate the sequence $x[n]=n-64$ for $n=0,\ldots,127$.
(a) Let $X[k]=\text{DFT} \{x[n]\}$. For various values of $L$, set to zero the “high frequency coefficients” $X[64-L]=\ldots=X[64]=\ldots=X[64+L]=0$ and take the inverse DFT. Plot the results.
(b) Let $X_{\text{DCT}}[k]=\text{DCT}(x[n])$. For the same values of $L$, set to zero the “high frequency coefficients” $X_{\text{DCT}}[127-L]=\ldots=X_{\text{DCT}}[127]$. Take the inverse DCT for each case and compare the reconstruction with the previous case.

6 **Filter design**
Design a discrete time low pass filter with the specifications given below:
- Sampling frequency = 2 kHz.
- Pass band edge = 260 Hz
- Stop band edge = 340 Hz
- Max. pass band attenuation = 0.1 dB
- Minimum stop band attenuation = 30 dB

Use the following design methodologies:
- Hamming windowing
- Kaiser windowing
- Applying bilinear transformation to a suitable, analog Butterworth filter.

Compare the obtained filters in terms of performance (accuracy in meeting specifications) and computational complexity.

**ii. Using DSP PROCESSOR**

1 Write an ALP to obtain the response of a system using linear convolution whose input and impulse response are specified.

1. Write an ALP to obtain the impulse response of the given system, given the difference equation.
2. Sampling of an Image.
3. Design of equiripple filters.
4. Application of frequency transformation in filter design.
5. Computation of FFT when N is not a power of 2.
6. Sampling rate conversion and plot of spectrum.
7. Analysis of signals by STFT and WT.
8. Delayed auditory feedback signal using 6713 processor.
9. Record of machinery noise like fan or blower or diesel generator and obtaining its spectrum.

Any other experiments can be added to supplement the theory.

PROTOCOL ENGINEERING

<table>
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Communication Model, software, subsystems, protocol development methods, protocol engineering process:

Network Reference Model: services and interfaces, protocol functions, OSI and TCP/IP model,

Protocols: Host to network interface protocols, network protocols transport protocols, application protocols;

Protocol Specifications: Components of protocol, service specifications, entity specifications, interface and interactions, multimedia protocol specifications, HDLC, ABP and RSVP specifications;

SDL: features, communication system using SDL, examples of SDL based protocol specifications, other specification languages;

Protocol Verification, FSM based verification, validation, design errors, validation approaches, verification and validation of ABP using SDL; Conformance testing, framework, conformance test architectures, test sequence generation methods, TTCN, multimedia testing,

MPLS Testing: Performance testing methods, testing of TCP and OSPF, interoperability testing, scalability testing;

Protocol Synthesis Algorithms, resynthesis, protocol implementation requirements, methods of implementation, protocol compilers, tools for protocol engineering Assignments / practical can be chosen from the Appendix of the mentioned reference books, particularly – book 1.

REFERENCE BOOKS:

ELECTIVE – II

CRYPTOGRAPHY AND NETWORK SECURITY

<table>
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Overview: Services, Mechanisms and attacks, OSI security architecture, Model for network security.


Block Ciphers and DES (Data Encryption Standards): Simplified DES, Block cipher principles, DES, Strength of DES, Block cipher design principles, Block cipher modes of operation, Problems.

Public Key Cryptography and RSA: Principles of public key cryptosystems, RSA algorithm, Problems.

Other Public Key Crypto Systems and Key Management: Key management, Diffie-Hellman key exchange, Elliptic curve arithmetic, Elliptic curve cryptography, Problems.


Authentication Applications: Kerberos, X.509 authentication service, Kerberos encryption technique, Problems.

Electronic Mail Security: Pretty good privacy, S/MIME, Data compression using ZIP, Radix-64 conversion, PGP random number generator.


Firewalls: Firewall design principles; Trusted systems, Problems.

REFERENCE BOOKS:


Wireless and Mobile Networks

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Review of fundamentals of wireless communication and networks. Wireless communication channel specifications, wireless communication systems, wireless networks, switching technology, communication problems, wireless network issues and standards.

Wireless body area networks (WBAN). Properties, network architecture, components, technologies, design issues, protocols and applications.


Wireless LANS. Network components, design requirements, architectures, IEEE 802.11x, WLAN protocols, 802.11 p and applications.
WMANs. IEEE 802.16, architectures, components, WiMax mobility support, protocols, broadband networks and applications. WWANs. Cellular networks, Satellite networks, applications.  


References:  

REAL TIME OPERATING SYSTEMS  
Subject Code : 10EC126  
IA Marks : 50  
No. of Lecture Hours /week : 04  
Exam Hours : 03  
Total no. of Lecture Hours : 52  
Exam Marks : 100  


Processing: Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline – Monotonic Policy, Dynamic priority policies.  

I/O Resources:  
Memory:  
Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash filesystems.  

Multiresource Services:  
Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion.  

Soft Real-Time Services:  
Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services.  

Embedded System Components:  
Firmware components, RTOS system software mechanisms, Software application components.  

Debugging Components:  

Performance Tuning:  
Basic concepts of drill-down tuning, hardware – supported profiling and tracing, Building performance monitoring into software, Path length, Efficiency, and Call frequency, Fundamental optimizations.  

High availability and Reliability Design:
Reliability and Availability, Similarities and differences, Reliability, Reliable software, Available software, Design trade offs, Hierarchical applications for Fail-safe design.

**Design of RTOS – PIC microcontroller. (Chap 13 of book Myke Predko)**

**References:**