Programme Structure and Detailed Syllabus of

MTech in Electronics and Communication Technology with Specialization in Signal Processing and Communication (SPC)

Offered by
Department of Electronics and Communication Engineering
Gauhati University
August, 2012
Approval Sequence in descending order

1. Formal permission given vide letter no GU/ACA/NEW COURSE/2012/252-56 Dated 27/09/2012 issued by Academic Registrar, Gauhati University.

2. Meeting of Faculty of Technology, Gauhati University dated 13-08-2012.

3. CCS, ECT, Gauhati University dated 19-06-2012

4. DAC, ECE, GU dated 20-1-2012


MTech in Electronics and Communication Technology with Specialization in Signal Processing and Communication (SPC)

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**Elective**

- A. Communication Networks
- B. Bio Signal and Image Processing
- C. Robotics
- D. Speech Processing
- E. Soft Computing
- F. Advanced Antenna Design
- G. Data Security
- H. Computer Vision
- I. Optical Communication
- J. Bio-medical Signal Processing
- K. Pattern Recognition
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Unit 1: Review
FFT-decimation in time and frequency, z-transform, sampling, quantization, ADC and DAC; IIR and FIR systems;

Unit 2: Information Theory
Definition- Uncertainty, Information and Entropy; Source coding, Mutual Information, Channel Capacity and Channel Coding Theory; Information Capacity Theorem; Rate Distortion Theory;

Unit 3: Effects of finite word length in digital systems
Introduction; Representation of numbers- fixed point, floating point; Rounding and Truncation Errors; Quantization Effects in ADC and DAC processes; Noise power from a digital system; Coefficient quantization effects in direct form realization of IIR and FIR systems;

Unit 4: Implementation of discrete systems
Structures for FIR systems- direct form, cascade form, frequency sampling and lattice structures; Structures for IIR systems- Direct form, Signal flow graphs and transpose forms, cascade forms, parallel forms, lattice and lattice-ladder structures; Round off effects in Digital filter structures;

Unit 5: Design of Digital Filters
Design of FIR- symmetric and anti-symmetric FIR filters, Linear pahse filters using windows and frequency sampling; FIR differentiators; Least square method- Pade approximation, FIR Least Squares Inverse (Wiener) Filter;

Unit 6: Prediction
Innovations representation of a random process; Forward and Backward Prediction; Solution to normal equations- Levinson-Durbin Algorithm, Schur Algorithm; Properties of Linear Prediction Filters; AR and ARMA Lattice-Ladder structure; Wiener filters for prediction;

Suggested Reading
1. Digital Signal Processing- Proakis, Pearson Education
2. Digital Signal Processing- Mitra, TMGH
3. Digital Signal Processing- Salivahanan, Vallavraj, Gnanapriay, TMGH
A: Linear Algebra

Unit 1: Vector Space
Binary operations on a set, Group and Field-definition; Definition and properties of vector space; Definition and properties of vector sub-space; Algebra of subspaces; basis of a vector space; finite dimensional vector space; homomorphism of vector space; Isomorphism of vector space; Disjoint subspaces;

Unit 2: Linear Transformations
Linear transformation, operator; range and null space of a linear transformation; rank and nullity of a linear transformation; Linear transformations as vectors; product of linear transformations; Invertible linear transformation; Singular and non-singular transformation; Matrices- definition, representation by transformation, trace of a matrix, trace of a linear matrix; Determinant of a linear transformation;

Unit 3: Inner Product Spaces
Definition, Euclidean and unitary space; Schwartz’s inequality; Orthogonally; Orthonormal set; Complete orthonormal set; Gram-Schmit orthogonalization; linear functionals and adjoint; self-adjoint transformation;

Unit 4: Bilinear transform
Bilinear forms-definition, bilinear forms as vectors, matrix as bilinear forms, symmetric bilinear forms; Decomposition theorems and eigen-analysis. Quadratic forms. Perron-Frobenius theorems.

B: Random Process

Unit 1: Probability and Random Variable
Definition, sample space, conditional probability, Baye’s theorem, Bernouli’s trials, Asymptotic theorems, Poison’s theorem and random points;
Random Variable- Definition, Continuous and discrete random variable, distribution and density functions; Conditional distribution; One random variable- Mean, variance, moments, characteristic functions; Two random variables- Mean, variance, moments, characteristic functions; Moments and conditional statistics; Transformation of random variables; Random process; Mean, Correlation and Covariance; Stationarity; transmission of a random process through a linear filter, power spectral density, Gaussian process;

Unit 2: Stochastic Process
Definition, first and second order statistics, Mean, Correlation and Covariance; Ergodic process; Spectral Representation of Stochastic process; Random walk, Brownian motion, Thermal noise, Poisson point, Shot noise, Modulation, Cyclostationary Process, Band limited Process;

Unit 3: Estimation
Spectral Estimation, Extrapolation and system identification, mean square estimation, prediction, filtering and prediction; Kalman Filters;

Suggested reading
1. Introduction to Linear Algebra- K. Hoffman and R. Kunze, PHI;
Course Objective
The course provides basic foundation of different aspects of Digital Communication and its applications.

Module 1. Random Process:
Probability theory, random variable, statistical averages, transformation of random variables, random process, stationarity, mean, correlation and covariance, ergodicity, transmission of a random process through a linear filter, power spectral density, Gaussian process;

Module 2: Pulse modulation
Sampling theorem, pulse analog modulations (PAM), Shaping of the transmitted signals spectrum, Equalization, Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM), Quantization; PCM- Limitations of PCM; Companding; DM, DPCM- preliminary idea; coding speech at low bit rate, APCM; CODEC;

Module 3: Digital Modulation techniques
Amplitude shift keying (ASK), Frequency Shift Keying (FSK), phase shift keying (PSK), Dual Phase Shift Keying (DPSK) schemes, Coherent binary PSK/ FSK; Coherent quadrature PSK; Coherent minimum shift keying; differential PSK Comparison of digital modulation schemes, M-array signaling scheme; QAM; Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).

Module 4: MODEM techniques:
Baseband transmission; modem principles & architecture;

Module 5: Spread Spectrum modulation
Definition; types-direct sequence & frequency hoping; pseudo-noise generation; Idealized model of a spread spectrum modulator; DS- & FH-spread spectrum modulation generation and detection; application; CDMA, GSM;

List of experiments.
1. Generation of ASK using kits/software/ ICs.
2. Generation of PSK using kits/software/ ICs.
4. Generation of BPSK using kits/software/ ICs.
5. Study of FDM using kits/ software.
7. Study of GSM using kits/ software.
8. Study of CDMA using kits/ software.

Suggested reading
1. Communication Systems- Simon Haykin, Wiley Eastern
2. Digital & Data Communication- Miller, Jaico.
3. Digital Communication- Simon Haykin, Willey Eastern
5. Digital Communication- Sklar, Pearson Education
Course objective
The course is an advanced treatment of different coding methods associated with
information systems.

Module 1
Review of sampling theorem-Practical aspects of sampling-quantization of analog
signals-Spectra of Quantization-wave from coding- PCM, ADPCM, Delta modulation-
ADM-Bit rate and SNR-calculation-Mean and prediction coding; Base band shaping,
binary Data formats, NRZ, RZ, Manchester formats- Baseband transmission-ISI- Effect of
ISI, Synchronization-application. correlative coding Eye Pattern-Adaptive equalization for
data transmission data reception matched filter, Optimum SNR. Introduction to
Information Theory: Information and Sources Uniquely Decodable Codes; Instantaneous
codes-. Construction of an Instantaneous code;. Kraft's Inequality. Coding Information
Sources:- The Average length of a code;

Module 2
Encoding for special Sources; Shannon's Theorems. Shannon's theorem for the
Binary Symmetric channel, Entropy and Source coding, Lossless coding techniques
including Huffman codes, Arithmetic codes, Lempel-Ziv coding, Lossy coding techniques,
Shannon coding theorem, Channel codes including Linear block codes, Cyclic codes, BCH
codes Convolutional codes. Finding Binary Compact Codes, Huffman's code. r-ary
compact Codes, Code Efficiency and Redundancy.

Module 3
Channels and Mutual Information: Information Channels, Trellis Coded
Modulation; Probability relations in a channel; Apriori and Aposteriori Entropies,
Generalization of Shannon's first theorem, Mutual Information. Properties of Mutual
Information, Noiseless and Deterministic channels,

Module 4
Cascaded channels, Channel Capacity, Conditional Mutual Information; Reliable
Messages through Unreliable channels: Error probability and Decision rules, the Fano
bound, Hamming distance, Random Coding; Ensemble performance analysis of block and
convolution codes; Introduction linear block codes-cyclic codes-Burst error detecting and
correcting codes-Decoding algorithms of convolution codes-ARQ codes performance of
codes.

Suggested reading
2. Information theory and reliable communication- R.G.Gallagar, Wiley New York,
1968.
A. Seminar
Each student shall collect information on an allotted topic related to the subject, analyze it and formulate an approach to make a presentation. The students shall submit a report on the allotted topic which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic.

Examination Scheme:
Report: 20
Presentation: 30
Total: 50

B. Term Paper

METHODOLOGY
A term (or research) paper is primarily a record of intelligent reading in several sources on a particular subject. The students will choose the topic at the beginning of the session in consultation with the faculty assigned. The progress of the paper will be monitored regularly by the faculty. At the end of the semester the detailed paper on the topic will be submitted to the faculty assigned. The evaluation will be done by Board of examiners comprising of the faculties.

GUIDELINES FOR TERM PAPER
The procedure for writing a term paper may consists of the following steps:
1. Choosing a subject
2. Finding sources of materials
3. Collecting the notes
4. Outlining the paper
5. Writing the first draft
6. Editing & preparing the final paper

1. Choosing a Subject
The subject chosen should not be too general.

2. Finding Sources of materials
   a. The material sources should be not more than 10 years old unless the nature of the paper is such that it involves examining older writings from a historical point of view.
   b. Begin by making a list of subject-headings under which you might expect the subject to be listed.
   c. The sources could be books and magazines articles, news stories, periodicals, scientific journals etc.

3. Collecting the notes
Skim through sources, locating the useful material, then make good notes of it, including quotes and information for footnotes.
   a. Get facts, not just opinions. Compare the facts with author's conclusion.
   b. In research studies, notice the methods and procedures, results & conclusions.
   c. Check cross references.

4. Outlining the paper
   a. Review notes to find main sub-divisions of the subject.
   b. Sort the collected material again under each main division to find sub-sections for outline so that it begins to look more coherent and takes
on a definite structure. If it does not, try going back and sorting again for main divisions, to see if another general pattern is possible.

5. Writing the first draft
Write the paper around the outline, being sure that you indicate in the first part of the paper what its purpose is. You may follow the following:
- statement of purpose
- main body of the paper
- statement of summary and conclusion

Avoid short, bumpy sentences and long straggling sentences with more than one main ideas.

6. Editing & Preparing the final Paper
a. Before writing a term paper, you should ensure you have a question which you attempt to answer in your paper. This question should be kept in mind throughout the paper. Include only information/ details/ analyses of relevance to the question at hand. Sometimes, the relevance of a particular section may be clear to you but not to your readers. To avoid this, ensure you briefly explain the relevance of every section.

b. Read the paper to ensure that the language is not awkward, and that it "flows" properly.

c. Check for proper spelling, phrasing and sentence construction.

d. Check for proper form on footnotes, quotes, and punctuation.

e. Check to see that quotations serve one of the following purposes:

f. Show evidence of what an author has said.

g. Avoid misrepresentation through restatement.

h. Save unnecessary writing when ideas have been well expressed by the original author.

i. Check for proper form on tables and graphs. Be certain that any table or graph is self-explanatory.

7. Term papers should be composed of the following sections:
1) Title page
2) Table of contents
3) Introduction
4) Review
5) Discussion & Conclusion
6) References
7) Appendix

Generally, the introduction, discussion, conclusion and bibliography part should account for a third of the paper and the review part should be two thirds of the paper.

Discussion
The discussion section either follows the results or may alternatively be integrated in the results section. The section should consist of a discussion of the results of the study focusing on the question posed in the research paper.

Conclusion
The conclusion is often thought of as the easiest part of the paper but should by no means be disregarded. There are a number of key components which should not be omitted. These include:

a) summary of question posed

b) summary of findings

c) summary of main limitations of the study at hand

d) details of possibilities for related future research

References
From the very beginning of a research project, you should be careful to note all details of articles gathered.
The bibliography should contain ALL references included in the paper. References not included in the text in any form should NOT be included in the bibliography. The key to a good bibliography is consistency. Choose a particular convention and stick to this.

**Appendix**
The appendix should be used for data collected (e.g. questionnaires, transcripts, ...) and for tables and graphs not included in the main text due to their subsidiary nature or to space constraints in the main text.

**Assessment Scheme:**
**Continuous Evaluation:** 40%
(Based on abstract writing, interim draft, general approach, research orientation, readings undertaken etc.)

**Final Evaluation:** 60%
(Based on the organization of the paper, objectives/ problem profile/ issue outlining, comprehensiveness of the research, flow of the idea/ ideas, relevance of material used/ presented, outcomes vs. objectives, presentation/ viva etc.)

**Total marks- 50.**
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**Unit 1: Introduction to Wireless Mobile Communications**
History and evolution of mobile radio systems; Types of mobile wireless services / systems - Cellular, WLL, Paging, Satellite systems, Standards, Future trends in personal wireless systems

**Unit 2: Cellular Concept and System Design Fundamentals**
Cellular concept and frequency reuse, Multiple Access Schemes, channel assignment and handoff, Interference and system capacity, Trunking and Erlang capacity calculations; cellular concept, spectral efficiency; design parameters at base station: antenna configurations, noise, power and field strength; design parameters at mobile unit: directional antennas and diversity schemes: frequency dependency; noise; antenna connections; field component diversity antennas; signaling and channel access: word-error-rate, channel assignment;

**Unit 3: Mobile Radio Propagation**
Radio wave propagation issues in personal wireless systems, Representation of a mobile radio signal; Propagation models, propagation path loss and fading- causes, types of fading and classification of channels; prediction of propagation loss: measurements, prediction over flat terrain, point-to-point prediction, microcell prediction model; calculation of fades- amplitude fades, random PM and random FM, selective fading, diversity schemes, combining techniques, bit error-rate and word-error-rate; Multipath fading and Base band impulse respond models, parameters of mobile multipath channels, Antenna systems in mobile radio;

**Unit 4: Modulation and Signal Processing**
Analog and digital modulation techniques, Performance of various modulation techniques-Spectral efficiency, mobile radio interference: co-channel and adjacent-channel interference, intermodulation, intersymbol and simulcast interference; frequency plans: channelized schemes and frequency reuse, FDM, TDM, spread spectrum and frequency hopping, Error-rate, Power Amplification, Equalizing Rake receiver concepts, Diversity and space-time processing, Speech coding and channel coding

**Unit 5: System Examples and Design Issues**
Multiple Access Techniques- frequency division multiple access, time division multiple access, code division multiple access, space division multiple access, operational systems, Wireless networking, design issues in personal wireless systems; Cellular CDMA: narrow band and wide band signal propagation, spread spectrum techniques, capacities of multiple access schemes; micro cell systems: conventional cellular system, micro cell system design, capacity analysis.

**Suggested reading**
1. Wireless digital communications- K.Feher, PHI,
2. Wireless Digital Communications Principles and Practice - T.S.Rappaport, Pearson Education
4. Mobile Communications- Schiller, Pearson Education
5. Wireless Communications and Networks -Stallings, Pearson Education
6. Wireless Communication Systems -Wang and Poor, Pearson Education
Semester | Course Code | Course | L | T | P | C
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2 | EL 521 | DSP Processor | 3 | 1 | 1 | 5

**Unit 1:** Introduction
Basic features, requirements, Computational characteristics of DSP algorithms and applications; Influence of Digital Signal processing in defining generic instruction-set architecture for DSPs.

**Unit 2:** Design requirement of DSPs-
High throughput, low cost, low power, small code size, embedded applications. Techniques for enhancing computational throughput: parallelism and pipelining.

**Unit 3:** Architecture
Data-path of DSPs- Multiple on-chip memories and buses, dedicated address generator units, specialized processing units (hardware multiplier, ALU, shifter) and on-chip peripherals for communication and control;
Control-unit of DSPs- pipelined instruction execution, specialized hardware for zero-overhead looping, interrupts;
Architecture of Texas Instruments fixed-point and floating-point DSPs: brief description of TMS320 C5x /C54x/C3x DSPs; Programmer’s model. Architecture of Analog Devices fixed-point and floating-point DSPs: brief description of ADSP 218x / 2106x DSPs; Programmer’s model. Advanced DSPs: TI’s TMS 320C6x, ADI’s Tiger-SHARC, Lucent Technologies’ DSP 16000 VLIW processors.

**Unit 4:** Applications-
A few case studies of application of DSPs for signal processing, communication and multimedia.

**Suggested Reading**
2. Digital Signal Processing in VLSI- R. J. Higgins, Prentice-Hall,
3. Texas Instruments TMSC5x, C54x and C6x Users Manuals.
5. VLSI Digital Signal Processing Systems- K. Parhi, John Wiley;
7. Digital Signal Processors- Kuo and Gan, Pearson Education;
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**Unit 1:** Discrete Random Signal Processing  

**Unit 2:** Spectrum Estimation  

**Unit 3:** Linear Estimation And Prediction  

**Unit 4:** Adaptive Filters  

**Unit 5:** Multirate Signal Processing  
Decimation and Interpolation by a factor; Sampling rate conversion by a rational factor; filter design and implementation for sampling rate conversion; multistage implementation of sampling rate conversion; sampling rate conversion of bandpass signals; sampling rate conversion by an arbitrary factor; applications-phase shifter, interfacing of digital systems with different sampling rates, digital filter banks, subband coding of speech signals, Quadrature mirror filters, Transmultiplexers, Oversampling ADC and DAC;

**Suggested reading**
2. Digital Signal processing - Proakis, Pearson Education
3. Adaptive Filter Theory- Haykin, Pearson Education
4. Statistical Signal processing- Srinath, PHI
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**Unit 1** Orbital Parameters  
Orbital parameters, Orbital perturbations, Geo stationary orbits, Low Earth and Medium orbits. Frequency selection, Frequency co-ordination and regulatory services, Sun transit outages, Limits of visibility, Attitude and orientation control, Spin stabilization techniques, Gimbal platform

**Unit 2** Link Calculations  
Space craft configuration, Payload and supporting subsystems, Satelite uplink - down link power budget, C/No, G/T, Noise temperature, System noise, Propagation actors, Rain and ice effects, Polarization calculations

**Unit 3** Access Techniques  
Modulation and Multiplexing-Voice, Data, Video, Analog and Digital transmission systems; Multiple acess techniques-FDMA,TDMA,T1-T2 carrier systems, SPADE, SS-TDMA, CDMA, Assignment Methods; Spread spectrum communication, Compression-Encryption and Decryption techniques;

**Unit 4** Earth Station Parameters  
Earth station location, propagation effects of ground, High power transmitters- Klystron Crossed field devices, Cassegrania feeds, Measurements on G/T and Eb/N0

**Unit 5** Satelite Applications  
INTELSAT Series, INSAT, VSAT, Remote sensing, Mobile satellite service: GSM. GPS, INMARSAT, Satellite Navigation System, GPS, Direct to Home service (DTH),Special services, E-mail, Video conferencing and Internet connectivity

**Suggested reading**

1. The Satellite Communication Applications Hand Book- Bruce R. Elbert  
   Artech House Boston
3. Satellite Communication- Dennis Rody, Regents, Prentice Hall,
4. Digital satellite communication- Tri T. Ha, McGraw Hill;
5. Digital communication satellite / Earth Station Engineering- K. Feher, Prentice Hall Inc
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**Course Objective**
The course provides an exposure to the different principles of image processing using digital means, applications and insights into Computer Vision and Machine Learning.

**Module 1: Introduction**
Steps in Digital Image Processing, Components of an Image Processing system, Applications. Human Eye and Image Formation; Sampling and Quantization, Basic Relationship among pixels- neighbour, connectivity, regions, boundaries, distance measures.

**Module 2: Image Enhancement**
Spatial Domain-Gray Level transformations, Histogram, Arithmetic/Logical Operations, Spatial filtering, Smoothing & Sharpening Spatial Filters; Frequency Domain- 2-D Fourier transform, Smoothing and Sharpening Frequency Domain Filtering; Convolution and Correlation Theorems;

**Module 3: Image Restoration**
Inverse filtering, Wiener filtering; Wavelets- Discrete and Continuous Wavelet Transform, Wavelet Transform in 2-D;

**Module 4: Image Compression**
Redundancies- Coding, Interpixel, Psycho visual; Fidelity, Source and Channel Encoding, Elements of Information Theory; Loss Less and Lossy Compression; Run length coding, Differential encoding, DCT, Vector quantization, entropy coding, LZW coding; Image Compression Standards-JPEG, JPEG 2000, MPEG; Video compression;

**Module 5: Image Segmentation**
Discontinuities, Edge Linking and boundary detection, Thresholding, Region Based Segmentation, Watersheds; Introduction to morphological operations; binary morphology- erosion, dilation, opening and closing operations, applications; basic gray-scale morphology operations; Feature extraction; Classification; Object recognition;

**Module 6: Colour Image Processing**
Colour models, Different processing techniques; Colour image filtering;

**Suggested Reading**
4. Digital Image Processing and Analysis- Chanda and Mazumdar, PHI
5. Digital Image Processing- Annadurai and Shanmugalakshmi, Pearson Education
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**Unit 1: Introduction**  
Network definition, architecture & requirement; types-LAN, MAN & WAN; Seven layers of the ISO-OSI reference model-functions of respective layers; different physical media & relative advantages-disadvantages, hardware aspects; TCP/IP layers & relation to the ISO-OSI model; Protocols-Aloha, CSMA, CSMA-CD/CA. Controlled access, Channelization;

**Unit 2: LANs**  
Wired-IEEE standard data link and physical layers, Standard Ethernet layer, Classes of Ethernet – bridged, switched, full-duplex, fast, gigabit; Wireless- IEEE 802.11-architecture, MAC sublayer, addressing mechanism, physical layer; Bluetooth and IEEE 802.15 - architecture, layers, radio layer, baseband layer, L2CAP, Logical Link Control and adaptation protocol, other upper layers; Connecting LANs- Connecting devices-Hubs, Repeaters, Bridges, Switches, Routers, Gateways; Backbone Networks- Bus, Star, Connecting remote LANs; Virtual LANs- membership, configuration, communication between switches, IEEE standard; Infrared LANs, Spread spectrum LANs and Narrow Microwave LANs; VSAT LANs;

**Unit 3: Wireless WANs**  
Cellular telephony- evolution, generations, basic working principle, frequency reuse, transmission, reception, roaming, GSM, CDMA; Satellite networks- orbits, footprints, working principles, modulation-demodulation, categories of satellites; Cordless system and WLL-basic principle, working, architecture, application; WIMAX and IEEE 802.16 Broadband Wireless Access Standards; Mobile IP and WAP- working, architecture, application;

**Unit 4: SONET/SDH**  
Architecture, signals, SONET devices, connections; SONET layers- Path layer, Line Layer, Section Layer, Photonic Layer, Device –Layer relationship; SONET Frames- frame, byte, bit transmission, STS-1 frame format, overhead summary, encapsulation; STS multiplexing- byte interleaving, concatenated signal, add/ drop multiplexer; SONET Network- Linear, ring, Mesh; Virtual tributaries;

**Unit 5: Virtual Circuit Network**  
Frame relay- Architecture, frame relay layers, extended address, FRADs, VOFR, LMI, Congestion control and QoS; ATM-design goals, problems, architecture, switching, ATM layers, congestion control and QoS; ATM LANs;

**Suggested Reading**
1. Data Communications and Networking- Forouzan, TMGH
2. Wireless Communications and Networks- Stallings, Pearson Education
3. Data Communications- Stallings, Pearson Education
4. Computer Networks- Tanenbaum, PHI
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**Unit 1:** Introduction
Evolution of robotics, industrial robots; Cognitive and Biological aspects; Fields of application and future scope;

**Unit 2:** Structural Design of Robot
Anatomy of robot; Manipulation, arm geometry, Degrees of freedom; drives and control (hardware) for motions. End effectors and grippers, pickups, etc. Matching robots to the working place and conditions; Interlock and sequence control, reliability, maintenance and safety of robotic systems;

**Unit 3:** Robot Design
Direct and Inverse Kinematics, Path Planning and Motion Control, Robotic Manipulators, Sensors and Actuators; Low-Level Robot Control; Navigation Algorithms and Sensor-Based Navigation; Robot Vision and Other Sensors; Multi-Agent Robotics; Expert Systems

**Unit 4:** Applications
Studies in manufacturing processes, e.g. casting, welding, painting, machine tools, machining, heat treatment and nuclear power stations, etc. Synthesis and evolution of geometrical configurations, robot economics, educating, programming and control of robots.

**Suggested reading**
2. *Robotics and Control* - Mittal, TMGH
3. *Robotic Control* - Fu, TMGH
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**Unit 1**: Introduction  
Definition, basic concepts, Types- voiced and unvoiced; Production of speech- Biological Model, Signal Processing Model; Application areas and trends; Steps of human-human communication; Speech reception and Comprehension by the listener; Digital model of speech perception;

**Unit 2**: Speech Signal Processing  
Spectral analysis- DTFT, STFT, DFT; Sinusoidal analysis; Cepstral Analysis; LP Analysis-LP and Inverse LP filters, LP-derived features;

**Unit 3**: Speech Coding  
Definition, Importance, Requirements, Speech coding trends, Classification- PCM, ADPCM, Transform domain coding, Sub band coding, Multi Pulse Linear Predictive Coding, Code Excitation Linear Prediction Coding;

**Unit 4**: Speaker Recognition  
Importance, Man-Machine interface, Automatic Speaker Recognition, Biometric speaker recognition, Speaker verification v/s Speaker Identification,. Text- dependence and independence, Closed set and opened set, Speaker recognition using pattern Recognition Methods, Feature Extraction, Pattern Classification Techniques- Vector Quantization, Dynamic Time Warping, Hidden Markov Model, Neural Networks; Pattern Comparison;

**Unit 5**: Speech Enhancement  
Definition, Requirements, Examples of degraded speech, Enhancement of single channel and multi channel speech; Time delay estimates;

**Suggested Reading**  
1. Digital Processing of Speech- Rabiner and Schafer, Pearson Education;
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<td>3</td>
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<td>Elective I: (E) Soft Computing</td>
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**Unit 1:** Artificial Neural Networks  
Basic-concepts-single layer perception-Multi layer perception-Supervised and unsupervised learning back propagation networks, Application;

**Unit 2:** Fuzzy Systems  
Fuzzy sets and Fuzzy reasoning-Fuzzy matrices-Fuzzy functions-decomposition-Fuzzy automata and languages- Fuzzy control methods-Fuzzy decision making, Adaptive Control, Applications;

**Unit 3:** Neuro-Fuzzy Modelling  
Adaptive networks based Fuzzy interfaces-Classification and Representation trees-algorithms –Rule base structure identification-Neuro-Fuzzy controls;

**Unit 4:** Genetic Algorithm  
Survival of the fittest-pictures computations-cross overmutation-reproduction-rank method-rank space method, Application;

**Unit 5:** Soft Computing And Conventional Ai  
AI Search algorithm-Predicate calculu rules of interface - Semantic networks-frames-objects-Hybrid models; Applications;

**Suggested Reading**  
2. Fuzzy Logic Engineering Applications- Timothy J.Ross; McGraw Hill;  
3. Neural Networks- Simon Haykin, Pearson Education  
4. Fuzzy Sets and Fuzzy Logic- George J.Klir and Bo Yuan, Prentice Hall ;  
Unit 1: Basics Concepts of Radiation
Radiation from surface current and current line current distribution, Basic antenna parameters, Radiation mechanism-Current distribution of Antennas, Impedance concept-Balanced to Unbalanced transformer;

Unit 2: Radiation from Apertures
Field equivalence principle, Rectangular and circular apertures, Uniform distribution on an infinite ground plane, Aperture fields of Horn antenna-Babinet's principle, Geometrical theory of diffraction, Reflector antennas, Design considerations - Slot antennas;

Unit 3: Synthesis of Array Antennas
Types of linear arrays, current distribution in linear arrays, Phased arrays, Optimization of Array Patterns, Continuous aperture sources, Antenna synthesis techniques

Unit 4: Micro Strip Antennas
Radiation mechanisms, Feeding structure, Rectangular patch, Circular patch, Ring antenna. Input impedance of patch antenna, Micro strip dipole, Micro strip arrays

Unit 5: EMI S/EMC/Antenna Measurements
Log periodic, Bi-conical, Log spiral ridge Guide, Multi turn loop, Traveling Wave antenna, Antenna measurement and instrumentation, Amplitude and Phase measurement, Gain, Directivity, Impedance and Polarization Measurement, Antenna range; Design and Evaluation;

Unit 6: Smart Antennas systems
Generalized array signal processing; Beam forming concepts-DOB, TRB & SSBF, Switched beam antennas, spatial diversity, and fully adaptive antennas for enhanced coverage, range extension & improvement in frequency reuse, interference nulling for LOS & Multipath systems, SDMA concepts and Smart antennas implementation issues;

Suggested reading:
1. Antennas- Kraus, John Wiley and Sons;
2. Antenna Theory Analysis and Design- Balanis, John Wiley and Sons
3. Antenna Theory- Collin and Zucker, Mc Graw Hill,
4. Smart Antennas for Wireless Communication:
   IS-95 and Third Generation CDMS applications- Liberti, Rappaport, PHI
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**Unit 1:** Conventional Encryption
Introduction, Conventional encryption model, Steganography, Data Encryption Standard, block cipher, Encryption algorithms, confidentiality, Key distribution

**Unit 2:** Public Key Encryption And Hashing
Principles of public key cryptosystems, RSA algorithm, Diffie-Hellman Key Exchange. Elliptic curve cryptology, message authentication and Hash functions, Hash and Mac algorithms, Digital signatures

**Unit 3:** IP Security
IP Security Overview, IP security Architecture, authentication Header, Security payload, security associations, Key Management

**Unit 4:** Web Security
Web security requirement, secure sockets layer, transport layer security, secure electronic transaction, dual signature

**Unit 5:** System Security
Intruders, Viruses, Worms, Firewall design, Trusted systems, Antivirus techniques, Digital Immune systems

**Suggested Reading**
1. Cryptography and Network security - William Stallings, Pearson Education
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**Unit 1: Introduction**
Camera- Pinhole and Lens Types; Human Eye; Sensing; geometric Camera Models; Geometric Camera Calibrations; Radiometry; Projections; Transforms- Fourier, Hough and Radon; Sources, Shadows and Shading; Colour- Generation, Human Perception, Representation, Model for an Image Colour; Surface Colour;

**Unit 2: Image Analysis**
Scene Segmentation and Labeling; Counting Objects; Perimeter Measurements; Following and Representing Boundaries; B-Splines; Least Squares and Eigen Vector Line Fitting; Shapes of Regions;

**Unit 3: Shape Representation and Description**
Introduction; Statistical Decision Theory; Pattern Recognition Principles; Clustering Approach- K- Means Clustering; Parametric Approach- Bayes’ Classifier; Relaxation Approach; Shape Similarity Based Recognition; Expert System;

**Unit 4: Mid-level Vision**
Image Segmentation using K-means clustering and Graph- Theoretic Clustering; Segmentation by fitting a model; Segmentation and fitting using probabilistic methods; Tracking with linear dynamic models;

**Unit 5: High Level Vision**
Probabilistic and inferential methods- templates using classifiers, building classifiers form class histograms, feature selection, neural networks, support vector machines; Recognition by relations between templates; Geometric templates from spatial relations;

**Suggested reading**
1. Two Tone Image Processing and Recognition-Chaudhuri and Dattamazumdar, Wiley Eastern;
2. Pattern Recognition and Image Analysis- Gose, Johnson , PHI
3. Computer Vision- Forsyth, Pearson Education
5. Pattern Classification and Scene Analysis- P. E. Hart and R. O. Duda, John Wiley;
7. Vision- D. Marr, Freeman and Co;
**Course Objective**

The course provides an insight into different aspects of Optical Communication, working principles, transmission and reception, systems associated and applications.

**Module I - Introduction**

Evolution of fiber types, guiding properties of fibers, cross talk between fibers, coupled modes and mode mixing, dispersion properties of fibers, nonlinear properties of optical fibers, SRS, SBS, intensity dependent refractive index; Fiber design considerations: diameter, cladding, thickness, low and high bit rate systems, characterization of materials for fibers, fiber perform preparation, fiber drawing and control, roles of coating and jacketing;

**Module 2 - Optical and mechanical characterization of fibres, optical cable design**

Design objectives and cable structures, fibre splicing, fibre end preparation, single and array splices, measurement of splicing efficiency, optical fibre connectors, connector alignments, optical sources for communication, LED, injection lasers, modulation technique, direct and indirect methods, optical waveguide devices

**Module 3 - Optical detectors**

Photodiodes in repeaters, receiver design, digital and analog , transmission system design, system design choices, passive and low speed active optical components for fiber system, micro-optic components, lens-less components, all fiber components;

**Module 4 - Optical fiber components**

Modulation and demodulation, signal formats, direction detection receivers, coherent detection; Optical IC components for optical fiber components, electro optic devices for FO communication, optical switching, polarization control, inter office transmission system, trunking system, performance and architecture, under sea cable system, optical fibers in loop distribution system, photonic local network; Access network - network architecture, HFC, FTTC, optical access network architecture, deployment considerations, upgrading the transmission capacity, SDM, TDM, WDM, application areas, inter exchange, undersea, local exchange networks; Packaging and cabling of photonics components- photonic packet switching, OTDM, multiplexing and demultiplexing, optical logic gates, synchronization, broadcast OTDM network, OTDM testbeds;

**Module 5 - Soliton communication -**

Basic principle, metropolitan optical network, cable TV network, optical access network, photonics simulation tools, error control coding techniques, nonlinear optical effects in WDM transmission;

**Suggested Reading:**

1. Optical Fibre Telecommunication - S E Miller, A G Chynoweth
2. Optical Fibre Telecommunication II - S E Miller, I Kaninov
3. Optical Fibre Telecommunication IV B - I Kaninov, T Li
4. Deploying Optical Network Components - Gil Held
Unit 1: Introduction
Origins of Bioelectric signals, Electrocardiogram (ECG), Electromyogram (EMG); Recording Electrodes- Silver-silver Electrodes, Electrodes for ECG, EEG and EMG; Physiological Transducers- Pressure Transducers, Temperature sensors, Pulse sensors; Sources of bioelectric potential, resting potential, action potential, propagation of action potentials in nerves; rhythmic excitation of heart;

Unit 2: ECG
Pre-processing, wave form recognition, morphological studies and rhythm analysis, automated diagnosis based on decision theory, ECG compression; Evoked potential estimation. EEG: Evoked responses, averaging techniques, pattern recognition of alpha, beta, theta and delta waves in EEG waves, sleep stages, epilepsy detection.

Unit 3: EMG
Wave pattern studies, biofeedback. application of signal processing techniques such as linear prediction, lattice - filtering & adaptive signal processing for extraction of physiological parameters;

Unit 4: Introduction to wavelets & time frequency models
Biomedical signal processing by Fourier analysis; Biomedical signal processing by wavelet; Multi resolution analysis; Fetal ECG & vesicular sound signals;

Unit 5: Speech Signals
Speech production model, inverse filtering techniques for extraction of vocal tract parameters, glottal inverse filtering; Electroglottographic signals; signal processing techniques for detection of pathologies in speech production system; speech synthesis and speech recognition in diagnostic and; therapeutic applications;

Unit 6: Medical imaging techniques
CT scan, ultrasound, NMR and PET; Experiments are based on acquisition of biomedical signals and implementation of algorithms covered in the course to characterize these signals.

Suggested Reading
1. Biomedical Signal Processing and Signal Modeling- E.N. Bruce, John Wiley and Sons,
3. Wavelets and Time frequency methods for Biomedical signal Processing- M. Akay, IEEE Press,
4. Digital Processing of speech signals- L. Rabinar, Pearson Education
5. Biomedical Instrumentation and Measurements-Cromwell, Weibell and Pfeiffer, PHI
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Students individually or two at the most will carry out a detail study on a topic and implement a related system. The study must include literature survey, similar work done previously, proposed work, modifications to be included, applications etc. A report is to be prepared and submitted under the guidance of a supervisor. The report should contain design, implementation and experimental details. The topics involved in the work should be related to the courses undertaken by the student till this portion of progression under the programme and have contemporary relevance. It can involve research and development oriented works and be carried out with an eye on the needs of the industry. The work must be defended through a presentation in front of a panel constituted by selected experts.
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Semester Total: 27 38 31 96

Students individually or two at the most will carry out a detail study on a topic and implement a related system. The study must include literature survey, similar work done previously, proposed work, modifications to be included, applications etc. A report is to be prepared and submitted under the guidance of a supervisor. The report should contain design, implementation and experimental details. The topics involved in the work should be related to the courses undertaken by the student till this portion of progression under the programme and have contemporary relevance. It can involve research and development oriented works and be carried out with an eye on the needs of the industry. The phase II involves the complete design of the work and the preparation of the report in continuation of the work carried out in the previous semester. The work must be defended through a presentation in front of a panel constituted by internal and external examiners.

GUIDELINES FOR PROJECT Work

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation. Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of a research project are publishable, the project should be communicated in the form of a research report written by the student. Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critiqued by the faculty guide and corrected by the student at each stage. The File is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation.

In general, the File should be comprehensive and include:

- A short account of the activities that were undertaken as part of the project;
- A statement about the extent to which the project has achieved its stated goals.
- A statement about the outcomes of the evaluation and dissemination processes engaged in as part of the project;
- Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting from the project;
- Any problems that have arisen that may be useful to document for future reference.

Report Layout

The report should contain the following components:

1. **Title or Cover Page.** The title page should contain the following information: Project Title; Student's Name; Course; Year; Supervisor's Name.
2. **Acknowledgements** (optional)-Acknowledgment to any advisory or financial assistance received in the course of work may be given.
3. **Abstract-** A good "Abstract" should be straight to the point; not too descriptive but fully informative. First paragraph should state what was accomplished with regard to the objectives. The abstract does not have to be an entire summary of the project, but rather a concise summary of the scope and results of the project.
4. **Table of Contents-** Titles and subtitles are to correspond exactly with those in the text.
5. **Introduction**- Here a brief introduction to the problem that is central to the project and outline of the structure of the rest of the report should be provided. The introduction should aim to catch the imagination of the reader, so excessive details should be avoided.

6. **Present Work and Methods**- This section should aim at experimental designs, materials used. Methodology should be mentioned in details including modifications if any.

7. **Results and Discussion**- Present results, discuss and compare these with those from other workers, etc. In writing these section, emphasis should be given on what has been performed and achieved in the course of the work, rather than discuss in detail what is readily available in text books. Avoid abrupt changes in contents from section to section and maintain a lucid flow throughout the thesis. An opening and closing paragraph in every chapter could be included to aid in smooth flow. Note that in writing the various sections, all figures and tables should as far as possible be next to the associated text, in the same orientation as the main text, numbered, and given appropriate titles or captions. All major equations should also be numbered and unless it is really necessary never write in “point” form.

8. **Conclusion**- A conclusion should be the final section in which the outcome of the work is mentioned briefly.

9. **Future prospects**

10. **Appendices**- The Appendix contains material which is of interest to the reader but not an integral part of the thesis and any problem that have arisen that may be useful to document for future reference.

11. **References / Bibliography**

**Stress should be given on latex based report generation.**

**ASSESSMENT OF THE PROJECT**

Essentially, marking will be based on the following criteria: the quality of the report, the technical merit of the project and the project execution. Technical merit attempts to assess the quality and depth of the intellectual efforts put into the project. Project execution is concerned with assessing how much work has been put in.

**Examination Scheme:**

Dissertation and work: 50%
Presentation / Viva Voce: 50%