3. ECE TODAY

1. INTRODUCTION

The Department of Electrical Communication Engineering at the Indian Institute of Science is probably the oldest and one of the best known Departments of its kind in India. Since its inception, ECE has been a centre of excellence in Electronics and Communications and has contributed immensely to the growth of Research and Teaching in these areas. Presently, Communication, Microelectronics and Signal Processing are the main areas of R&D effort in the Department. Teaching programmes are also focussed along similar lines and beginning from August 1997 the M.E. programme will, be offered as three independent Masters' courses. The Department has also been an active partner with many Government and public/private sector agencies in translating research ideas into useful products and systems. Over 2000 students have graduated from this Department and have gone on to occupy key positions in academic institutions, R&D laboratories and industry in India and abroad. The Department strives to contribute to the scientific and technological goals through teaching, research and industrial interaction. It is an active participant in many technological projects of national importance and is constantly in the process of providing a vision for future technological trends in the Country. In all its endeavours, it pursues excellence in accordance with the noble traditions of the Institute.

2. LABORATORIES/FACILITIES

2.1 Research Laboratories:

Communication Networks Laboratories:
Popularly known as the ERNET lab, these laboratories have been functioning as a part of the DOE/UNDP funded Education and Research NETwork project. All laboratories of the department, the library, and the office are networked over a thick ethernet LAN that is bridged to the campus FDDI network. The ERNET laboratory houses one of the major backbone nodes of the ERNET network, through which the IISc campus is connected to the Internet. The laboratories have several workstations and PCs, and facilities for high-speed hardware development.

Photonics Laboratories:
Photonics laboratories have facilities for optical communication including optical spectrum analyzer, bit error rate measurement equipment, high speed sources and detectors, and integrated optics fabrication facilities. Experimental systems for the generation of ultra short optical pulses and their characterization have been added recently.

Microwave Laboratory:
Facilities for experimentation in microwaves, electromagnetics and antennas, such as a microwave vector network analyzer and a microwave anechoic chamber, are available.

Electronic Devices and Microelectronics Laboratories
This laboratory has facilities for building microelectronic devices, structures, transducers and sensors, and composite materials for design of electronic devices. The hybrid circuit laboratories have complete facilities for thick and thin film hybrid circuits technology.

Digital Signal Processing Laboratory:
The Digital Signal Processing (DSP) laboratory has been setup under the Telematics project sponsored by MHRD. This laboratory is also a partner in the University Partnership Program of Analog Devices, USA. The laboratory has PCs DSP processor boards.

Some of the other associated laboratories in the area of signal processing are

- Adaptive Signal Processing Laboratory
- Digital Array Processing Laboratory
- Biomedical Signal Processing Laboratory

Acoustics and Underwater Acoustics Laboratory
These laboratories have computing facility for simulation work, water tanks for conducting under-water experiments, and acoustic anechoic and reverberation chambers for conducting acoustic experiments.

Speech and Audio Processing Laboratory
This lab comprises of several PCs with speech and audio signal input and output capability along with good microphones, headphones, audio amplifier, speaker facilities. Several speech/audio databases are maintained for experimentation. A sound treated studio has been setup for digital audio/video perception experiments.

Visual Communication Laboratory
This laboratory has image and video handling capabilities including video camera, digitizer, video recorder, video effects hardware, large multisync display, various software (some

developed in-house) for compressing/editing/ displaying image and video, and has PCs as computing resources for simulation work.

2.2 Teaching Laboratories

Digital Electronics Laboratory:
This laboratory has the facilities for digital hardware implementation and testing.

Microprocessor Application Laboratory:
These laboratories contain microprocessor- and DSP-based developmental systems, computing facilities, and GPIB based programmable instrumentation system. PC laboratory This lab has several PCs and workstations that are networked and provides a general computing facility for the course students of the department.

2.3 Library

The computerized departmental library has over 2000 reference books, journals/proceedings and theses.

3. ACADEMIC WORK

The faculty members offer courses at the graduate level and continuously update the contents of the existing courses and introduce new courses to keep abreast of the latest developments in the fields of interest

3.1 Degree Programmes

The Department currently offers 2 research programmes and 2 course programmes, all at postgraduate level. As mentioned in the introduction, 2 new M.E. programmes, one in Signal Processing and one in Microelectronic Systems will be introduced in 1997.

Ph. D.: Research programme; admission requirement: Master's degree in Engineering; selection: through interview (twice a year); award of degree: based on the thesis only; typical duration: 4 years.

M. Sc. (Engineering): Research programme; admission requirement: Bachelor's degree in Engineering or Master's degree in Science; selection: through GATE followed by interview (twice a year); award of degree: based on the thesis only; typical duration: 2 years.

M. E. : Course programme; admission requirement: Bachelor's degree in Engineering; selection: through GATE (once a year); award of degree: based on the course credits and project; duration: 1.5 years.

The M. E. (3 semester) programme is currently under revision. It is planned that two new M.E. programmes - M. E. in Signal Processing (jointly with the Electrical Engineering Department) and M. E. in Microelectronic Systems (jointly with CEDT) will be introduced from August 1997. At the same time, the present M. E. (ECE) will be restructured and renamed as M. E. in Telecommunication.

M. E. (Integrated): course programme; admission requirement: Bachelor's degree in Science; selection: through IISc Entrance test (once a year); award of degree: based on the course credits and project; duration: 4 years.

The M. E. (Integrated) programme is being discontinued from August 1997.

3.2 Courses currently offered

E0-262	Multimedia Information Systems
EO-283	Switching Theory VLSI Design
	(New) Testing and Testability of Digital systems
E1-141	Signals and Systems
E2-101	Probability Theory
E2-111	Principles of Communication Systems
E2-201	Information Theory and Coding
E2-202	Random Processes
E2-204	Stochastic Processes Queuing Theory
E2-221	Communication Networks
E2-222	Switching Statistical Multiplexing in Telecommunication Networks
E2-223	Communication Protocols
	(New) Advanced Digital Communication
	(New) Wireless Mobile Communication
	(New) Modulation and Coding Theory
E3-111	Devices Analog Electronics
E3-131	Digital Electronics
E3-151	Electronic Measurements Instrumentation
E3-161	Electronic Packaging Production
E3-201	Network Theory
E3-211	Solid State Devices
E3-213	Microelectronics
E3-223	Designing with ASICs
E3-234	Digital Data Display Systems
E3-241	Communication Electronics
E3-351	Microelectronic Compatible Sensor Technology
E7-101	Optical Electronics
E7-211	Integrated Optics
E7-221	Optical Communication

E7-231 Fiber Optic Networks
E8-101 Electromagnetic Theory Antennas
E8-121 Microwave Techniques
E8-211 Antenna Theory Practice
E8-221 Microwave Devices
E8-222 Microwave ICs
E8-231 Microwave Communication
E9-201 Digital Signal Processing
E9-211 Optimum Signal Processing
E9-212 Spectrum Analysis
E9-221 Digital Signal Compression
E9-231 Digital Array Processing
E9-252 Ocean Acoustics
E9-261 Speech Information Processing
E9-281 Biomedical Signal Processing
(New) Designing with DSPs
(New) Advanced Topics in Digital Signal Processing

3.3 Recent Conferences, Workshops and Short Courses conducted

Conferences/Workshops

1. Workshop on Signal Processing, communication and Networking
July 23-26, 1990

2. Workshop on Recent Advances in Signal Processing and Communications
Jan 18-20, 1993

3. Conference on Signal Processing and communications
Aug 9-12, 1995

4. First DRDO-IISc workshop on Signal Processing and Communications
Aug 27-28, 1993

5. Second DRDO-IISc workshop on Signal Processing and Communications
Aug 26-27, 1994

6. Third DRDO-IISc workshop on Signal Processing and Communications
Aug 25-26, 1995

7. Conference on Emerging Optoelectronic Technologies (CEOT '91), Dec 16-21, 1991

8. Conference on Emerging Optoelectronic Technologies (CEOT '94), July 18-22, 1994

Short Courses

1. First short course (DRDO-IISc) on "Higher Order Statistical Signal Processing and Wavelet Transform"
Jan 31- Feb 5, 1994

2. Second short course (DRDO-IISc) on "Selected Topics in Signal Processing"
Feb 6-14, 1995

3. Third short course (DRDO-IISc) on "Selected Topics in Signal Processing and Communication"
Feb 26 - March 2, 1996

4. Short course on Telematics
Aug 12-20, 1991

5. Short course on Telematics : Digital Communication and Broadband Communication Networks
Aug 2-12, 1994

6. Tutorial on ATM Networking Technology , Nov 20-23, 1995.

4. RESEARCH WORK

The research activity in the department is currently in the following areas: Communications - Theory and Systems, Communication Networks and Protocols, Microwave Communication, Photonics and Optical Communication; Signal Processing - Ocean Acoustics, Audio Signal Processing, Biomedical Signal Processing, Image/Video Processing, Array Signal Processing; Space-Time Signal Processing for Mobile Communication, Wavelets and Multirate Signal Processing; Microelectronics and Instrumentation - Materials, Devices, Integrated Circuits, Fuzzy Logic Systems, Logic Synthesis and Intelligent Sensors and Instrumentation.

4.1 Communication Networks

In the area of task scheduling in parallel processing systems, the effect of the distribution of the number of tasks in a job, and the job partitioning granularity has been studied. Scheduling strategies in an input queuing ATM switch that offered different types of bursty traffic at its various inputs was studied and it was shown that, when output conflict occurs, there is a significant advantage to serving a cell that comes from a less bursty input. By introducing information delays into some classical formulations of stochastic control problems in queues, a complete characterization of optimal control policies was obtained. This work has been applied to the control of traffic in high-speed integrated communication networks.

Mustiaccess dual slotted unidirectional bus networks were studied. A variation of the Distributed Queuing access protocol was analyzed, wherein packet access delay was partitioned into a round-trip propagation delay bounded component and waiting time in a slotted non-preemptive priority queue. The access problem for two nodes was formulated as a total expected discounted lengths. Optimal schedulers were obtained for zero and half-slot propagation delay cases. Shared medium fast packet switching was studied, wherein switch scheduling algorithms were analyzed for purposes of input buffer sizing.

4.2 Cellular Networks

Most of the research activities are in the area of channel assignment algorithms. Investigations have been carried out recently into the issues of fairness, pricing and revenue maximization in the design of channel assignment algorithms. The performance of specific algorithms, notably the Maximum Packing algorithm, has also been studied. The problem of optimal cell-site location is also being investigated.

4.3 Mobile Cellular Communications

Research in this area was focused on the problems of handover management and channel allocation in mobile cellular systems. Some new techniques invented/developed are:

1. Handover prioritization with weighting of power and its derivative
2. Most-critical-first technique for channel allocation handover calls
3. Handover call look-ahead scheme with pre-handover zones
4. Handover channel exchange technique
5. Weighted prioritization scheme with new call queuing
6. Handover management techniques for highway microcellular systems
7. Directional channel borrowing scheme without locking in cochannel cells

4.4 Microwaves

Study of propagation characteristics of microstrip transmission lines using high superconducting films.

Analysis and Synthesis of Arbitrary Antenna arrays using circular and parabolic arrays.

Study of microstrip antenna array- Microstrip ring antenna - mutual effects in an array- Stacked structures for bandwidth enhancement. Design of microstrip antenna array- with little back radiation to minimize the biological effects of the field on the user.

4.5 Photonics and Optical Communication

THEORY OF OPTICAL WAVEGUIDES: Practical applications of fiber and integrated optics requires understanding the theory of light propagation in optical waveguides. Beam Propagation Method (BPM) and Coupled Mode Theory (CMT) have been used to analyze a variety of guidedwave devices. Coupled Mode Theory has been applied to solve the problem of light propagation in thin clad fiber, and a three fiber system. A combination of CMT, BPM and the electrooptic effect was used to analyze waveguide devices of an arbitrary geometry (inclined or curved).

NONLINEAR OPTICS: Soliton propagation, Raman and Bragg scattering in a Kerr medium and copropagation of two optical pulses of different frequencies in birefringent fibers are some of the key issues considered. Another area of study is second order processes in nonlinear media. Detailed theoretical and experimental studies on planar and crystal core fibers were carried out and methods of phase matching for efficient SHG were analyzed.

PHOTONIC SWITCHING : Novel photonic switching architectures such as the CNET and SSPIRAL were studied and optimal real estate utilization in switch arrays was investigated. Studies on self-routing and fault-tolerant architectures, implementation aspects, and requirements of input/output queuing for better throughput-delay performance were carried out. A novel method for tuning of a directional coupler based switch was demonstrated.

4.6 Optical Networks

Research activities are in the areas of design, architecture and performance evaluation of both broadcast and wavelength-routing optical networks. Research activities include performance analysis of media-access protocols for broadcast optical networks, routing and wavelength assignment algorithms for wavelength-routing optical networks, and virtual topology design algorithms. The design, development and fabrication of an integrated optic, acoustooptic tunable filter has been undertaken. The long term goal is to develop a prototype wavelength routing optical network.

4.7 Array Signal Processing

The research in this area is focussed in the analysis of interpolated and uniform circular

arrays with spatial smoothing, and adaptive algorithms for eigen-subspace estimation.

4.8 Space-Time Signal Processing for Mobile Communication

The research in this area is focussed in blind separation of multiple co-channel digital signals arriving at a base station antenna array in the presence of ISI and CCI, blind channel identification and equalization based on second-order statistics, beam forming for fading channels, recursive channel identification using antenna array, ML and LS methods for Ricean fading channels, improving SNR in cellular CDMA with antenna array.

4.9 Wavelets and Multirate Signal Processing

The research in this area is focussed in sub-band adaptive filtering for acoustic echo cancellation, tree-structured filter banks for signal compression, discrete wavelet multitone modulation for data communication and use of wavelet-based diversity strategy for unpredictable communication links.

4.10 Speech And Audio Processing

Speech Recognition: Keyword Spotting using "garbage" modelling : ergodic, on-line, no garbage models; noise robustness :projection distance measure new features : level-crossing intervals, TFR based approach corrective learning instead of ML learning.

Phoneme Recognition: HMM approach : new HMMs incorporating phonemic properties inhomogenous-HMM, trend-HMM, left-context-HMM, etc. better phoneme recognition accuracy on TIMIT database Neural Network approach (only classification).

Multi-plane MLP architecture : separate MLP network for each phoneme leads to better learning of the NN.

Speech Enhancement: new method of VQ based iterative Wiener filtering performs better than spectral subtraction and MAP estimation .

Speech/Audio Compression: Variable rate coding - useful in voice mail and mobile applications optimized CELP like coders for different classes of speech sounds closed loop or open loop determination of the coder type.

Perceptual audio coding: improvements to masking threshold determination transform coding of prediction residual instead of the signal Hi-fi Audio Effects: Efficient DSP algorithms for real-time processing (TMS320-C30) for quasi-stereo, surround sound, enhanced localization, 3D-sound, audio morphing, etc.

4.11 Image/Video Compression

New Algorithms: Image Vector Quantization - fast codebook search algorithms to reduce complexity, analytical methods in memory VQ to reduce excessive dependence on the training sequence, variable dimension (variable block size) VQ encoding and codebook design, heterodimensional tree structured VQ encoding and codebook design; Transform/Subband Coding — using nonuniform filter bank based transform coding that retains the advantages of both subband coding (nonuniform spectral bands) and transform coding (effortless time-varying analysis).

Lossless Image Coding — proposed switching theoretic approach to image compression using logic minimization. Work on Standards: JPEG algorithm for image-specific and rate-specific JPEG quantizer design, implementation of fast DCT on a DSP processor.

Related Area: image presentation/printing using halftoning, an important aspect of multimedia. New halftoning algorithms such as tracking based halftoning based on noise thresholding, iterative error diffusion vector quantization based combined halftoning and compression. VIDEO COMPRESSION:- New Algorithms: motion field coding that includes efficient coding of motion vectors, motion field prediction, motion field modelling for camera motion, etc.

Work on Standards: H.261 quantizer selection strategy, MPEG-I video plus layer-III audio complete encoder-decoder implementation in software. Developmental Work: Implemented a PC-based video library service through ethernet that achieves real-time software-only decoding of full-rate color near-QCIF video; real-time low-end DSP based encoding for this system.

4.12 Microelectronics and Instrumentation

The focus of research work in this area was on new techniques for programmable nonlinear ADCs (NADCs). The following new NADCs have been developed

NADC using optimal-sized ROM; ROM-prefetch high speed NADC; High speed hybrid NADC; Piecewise linear approximation NADC; PLS-based NADC; Curve runup/rundown NADCs; Charge-balancing NADC; Improved A-law encoding NADC; Algorithmic A-law NADC; Multimicroprocessor-based NADC

These NADCs are superior to those reported earlier with respect to digital programmability, IC

realizability, hardware simplicity, and conversion speed. The operation of these NADCs have been verified by experimental implementation, computer simulation and/or analytical evaluation.

4.13 Fuzzy Logic Systems

Two new fuzzy logic processing architectures have been proposed and their performance evaluation has been carried out. They are superior to some of the reported architectures in terms of hardware requirement and processing speed.

4.14 Programmable Instrumentation

Research in this area has resulted in the development of a GPIB instrument— Analog Signal Multiplexer. A new fast functional test generation technique developed for Finite State Machines. Based on a new functional fault model, high quality test sequences can be efficiently derived from a functional description of the logic

4.15 Logic Synthesis and Testing

New algorithms for test generation and fault simulation of path delay faults in combinational logic circuits developed. A novel "line delay fault model" proposed and a two-pass test strategy outlined to obtain high quality path delay test Image data compression formulated as a Boolean function minimization problem and efficient switching-theoretic techniques developed for lossless compression of digital image data. Compression obtained is comparable to the best existing schemes

A novel approach based on Boolean Transforms developed to drastically reduce the size of the PLA implementation of several switching functions. Currently work is in progress to extend the transform idea to the synthesis of efficient multi-level logic circuits.

Fast algorithms proposed for fault simulation of combinational as well as sequential circuits. A two-level logic minimizer which is faster than existing minimizers for many classes of functions implemented

5. CONSULTANCY WORK

The faculty members of the department are involved in various sponsored projects from several government agencies and industries in the public and private sectors within India and other countries. Following is a list of major projects and consultancies in the past few years.

Performance analysis and performance optimization of the call processing subsystem of the C-DOT Digital Switching System; funded by C-DOT; investigator: Prof. Anurag Kumar 1990.

Development of a large model version of a TCP/IP protocol software package; funded by ITI; investigator: Prof. Anurag Kumar; 1994—95.

Traffic engineering in a GSM cellular mobile network with full-rate and half-rate mobiles; funded by Philips Kommunikations Industrie AG, Nuremberg, Germany; investigators: Prof. Anurag Kumar and Dr. Sivarajan; 1994—1995.

Modelling, performance analysis and overload control design of the ITI digital switching system; funded by ITI; investigators: Prof. Anurag Kumar and Prof. Vinod Sharma(EE Dept., IISc); 1994—95.

6. COOPERATIVE PROGRAMMES

With a view to strengthen interaction with industry and to bring about practical utilization of R&D efforts of the faculty and students of the Department, a number of cooperative programmes have been taken up. Specifically, MOUs have been signed with BNR (NORTEL), Samsung Electronics, and NOKIA which provide for student scholarships, faculty exchange, consultancy and sponsored research and such other cooperative programmes.

Cooperative programmes with Universities such as Helsinki University (Finland), University of Keiserslauten (Germany), Stanford University (USA), and others have helped to establish international participation and contact between the various groups in the Department and the other universities.

7. FACULTY/STAFF/STUDENTS

7.1 Faculty

A Selvarajan, Professor and Chairman
G V Anand, Professor
Prabhakar S Naidu, Professor
V Umapathi Reddy, Professor
A P Shivaprasad, Professor
B S Sonde, Professor
Mandavilli Satyam, Honorary Professor
Anand Kumar, Emeritus Scientist
D Narayana Dutt, Associate Professor
Anurag Kumar, Associate Professor
Anamitra Makur, Associate Professor
Utpal Mukherji, Associate Professor
T V Sreenivas, Associate Professor
T S Vedavathy, Associate Professor
Pallapa Venkataram, Associate Professor

D B Ghare, Principal Research Scientist
Dinesh K Anvekar, Assistant Professor
K V S Hari, Assistant Professor
James Jacob, Assistant Professor
Kumar N Sivarajan, Assistant Professor
Malati Hegde, Senior Scientific Officer
M K Ravishankar, Senior Scientific Officer
M V Srinath, Senior Scientific Officer
Victor Anand Raj, Scientific Officer
T Badrinarayana, Scientific Officer
S V Gopalaiah, Scientific Officer
K Sivasankara Reddy, Scientific Officer
Anandi Giridharan, Technical Officer
E S Shivaleela, Technical Officer

7.2 Staff

Office Staff
A V Leelavathi, Personal Assistant
Susheela Nagaraj, Personal Assistant
V. araswathi, LDC
R Srinivasa Murthy, LDC
S R Ramakrishna, Attender

Laboratory Staff
R Madaiah, Laboratory Assistant
M Ramachandra, Laboratory Assistant
G S Hegde, Laboratory Assistant

Workshop Staff
C Thiruvengadam, Mechanic ' B'
C Subramany, Mechanic 'B'
C Kattaiah, Mechanic 'B'
P Arunachalam, Mechanic 'C'
N Balasubramani, Mechanic 'C'
R Muniraju, Laboratoy Helper
S Irudayaraj, Laboratory Helper
K P Babu, Laboratory Helper
G Rossaiah, Laboratory Helper
Rupendra Raju, Laboratory Helper

Other

7.3 Students on roll (1996-97)

Ph. D.
Anantha Kumar Majhi
Abraham Santosh Paul
Anirban Roy
Badrinarayana T
Bipul Chandra Paul
Nataraj, C.R.
Abhilash G
Gagan Bihari Rath
Joshi George
Kavitha V.
Lakshmipathi S
M.N.Shanmukha Swamy
Maheswara Reddy K
Manish Gupta
Natarajan S.R.
Prem Kumar Gadaey
Prodip Mandal
Rajeev Shorey
Rajesh M.K.
Rmabrahman, R
Sai Shankar N
Saswati Sarkar
Sethu Selvi
Shaibal Mitra
Siva Sankara Reddy K.
Sreenivasa Rao
Sridharan, M.K.
Sriram S

M.Sc.(Engg.)
Abhijit Chakrabarti
Aniruddha Diwan
Anupama Toshniwal
Debashis Ghosh
Gupta AVT
Indu Shekhar Das
Muthuvel A
Nayak J
Prabhu T
Rajanish
Ram Kumar M
Renu M.R.
Sarala S
Shanthi S
Shishir KL
Shivaleela ES
Shreekanth Lakshmeshwar
Swaminathan KS
Tushar Tripathi
Vijay Kumar G
Vinod Menzes
Viswanath G.

M.E.
I Year
Amit Vishvambhar Mate
Anand Santhana Krishnan
Archana Somashekara
Arindam Raychaudhuri
Basker P
Deepak Mahajan
Joby Joseph
Korada Ramkishor
Krishnan TN
Madhukar BR
Mallikarjun B.Marg
Mohammad Ather Khan
Nagaraj B
Narayana Raju KS
Navaneethakrishnan R
Navin Kumar Agrawal
Potbhare Rajabhau Mahadev
Rahul Agrawal
Rajesh Khanna
Sabu Emmanuel

Sanjay SG
Santosh
Shine M Thomas
Sreelatha J
Subhasis Das
Sunil Alias Balwantrao
Tapan Kumar Nayak
Tushar Kanti Adhikary
Vadapalli VVJ Raghu
Visweswaran I
Vyasaraj S

II Year
Abil Ali
Alok Kumar Singh
Anantha Ramu B.K.
Anshuman Gupta
Arvind Pundlik Mandpe (SC)
Ashish Vaishya
Ashish Verma
Ashutosh Kulshreshtha
Atul Suresh Joshi
Chacko Thomas
Debashish Pramanik
Ganesh K Koppisetti
Gopi Krishna C
Hemanth S Borale
Jagadish N.Grandhi
Jayaram
Pala Srinivasa Rao
Pramit A Chavda
Sachin S Deo
Sadafule Rahul Dinkar
Samvid S Shah
Sathyanarayana DV
Soumya Jana
Sudip Ghosal
Yoganand R

M.E(Int.)

I Year:
Amit Agarwal
Dinesh Kumar
Kaushik Dutta Manujdar
Natesan B
Nihar Ranjan Saha
Satyaki Datta
Sethuraman G

II Year
Anand A
Arindam Roy
Dipetendu Mitra
Jitendra Kumar Singh
Padmagowri P
Patnaik Sanjay Kumar
Pradeep PP
Rajan Srivastava
Rileen Sinha
Saran Sajesh Kumar
Shobanjali R
Shrikumar Sharma B
Sriram S
Suman Mukherjee

III Year
Abhijit Sinha
Anirban Sarkar
Bharat B
Daniel D Ezekiel
Devika R
Gautam Saha
Girish G
Jitendra Singh Yadav
Mainak Chatterji
Natwar Modani
Radhakrishnan N
Raghu Raman
Shailendra Sinha
Singaraju Gouri Sankar
Sividya N
Vikram S

IV Year
Aparna B
Chandresh Tiwari
Kaushik Das
Madhavi kumari GVNS
Madhumitha Ghar
Mrinalini L
Rajesh Kumar Jha
Sachin Purushotam Desai
Sankar Kumar Singha
Sathish kumar R
Shashi Bhushan Tripathi
Tatagato Mukhopadhyay
Vidyacharan B
Visweswaran B

8. FACULTY PROFILE

A Selvarajan
Professor and Chairman

Ph: 334 0563, 309 2278, 309 2283
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Received Master of Science degree in 1964 from Annamalai University and Ph.D. from Indian Institute of Science in 1969. Joined the Electrical Communication Engineering Department of IISc in Jan 1972 as lecturer. Has been a visiting Scientist at Uppsala University Sweden (1969-70), University of Arizona (1977-78), Technical University of Denmark (May-July 1986), University College, London (May-July 1987) and International Centre for Theoretical Physics, Trieste (May-June 1991). Fellow of IETE (India) Fellow of Optical Society of India. J C Bose memorial award 1992 from IETE and IETE Students' Journal paper award.

Currently working on linear and nonlinear optical waveguide theory, integrated optics, photonic switching, optical communication and fiber optic sensors.

G V Anand
Professor
Ph: 309 2277 email: anandgv@ece.iisc.ernet.in

Received B.Sc. and M.Sc degrees in Physics from Osmania University in 1962 and 1964 respectively, and Ph.D in Electrical Communication Engineering from Indian Institute of science in 1971. Joined the faculty of ECE Department, IISc in 1969. Commonwealth Academic Staff Fellow, University College London (1978—79). Fellow, IETE Fellow, Acoustical Society of India.

Currently working on ocean acoustics, with particular reference to propagation, scattering, array processing, underwater acoustic imaging, and tomography. Nonlinear propagation of acoustic and optical waves. Chaotic signals and systems.

Prabhakar S Naidu
Professor
Ph: 309 2442 email: psn@ece.iisc.ernet.in

Received B.Sc.(Hon) and M.Tech. from IIT, Kharagpur; Ph.D., UBC, Canada, 1965). Humboldt Fellow (1979-80) (at Philips Forschungslaboratorium, Hamburg, Germany) National Research Council (USA) Senior Research Associate (1988-1989), Naval Postgraduate School, USA

Currently working on underwater signal processing; tomographic 3D imaging; geophysical signal processing.

V Umapathi Reddy
Professor

Ph: 309 2280 e-mail:vur@ece.iisc.ernet.in

Received B.E. (Tele-communication Engineering) from Osmania University, Hyderabad, 1962; M.Tech (Electronics and Electrical Communication Engineering), Indian Institute of Technology, Kharagpur, 1963; Ph.D. (Electrical Engineering), University of Missouri, 1971. Assistant Professor, IIT, Madras (1972 - 1976); Professor, IIT, Kharagpur (1976 - 1979); Visiting Professor, Stanford University (1979 - 1982); Project Director, Research & Training Unit for Navigational Electronics, Osmania University (1982 -1988); Visiting Professor, Stanford University (1986 - 1987); Professor, IISc (1988-); Visiting Professor, University of Iowa (June-July 1991), Stanford University (March-June 1994), Visiting Scientist, RCI, Hyderabad (Sept. 1995-Feb. 1996), Visiting Professor, Stanford University (March-Sept. 1996); Fellow of the Indian National Science Academy, Fellow of the Indian National Academy of Engineering Fellow of the Indian Academy of Science Fellow of the IETE (India) S. K. Mitra Memorial Award 1989 from IETE.

Currently working on adaptive algorithms, antenna arrays, array processing for mobile communication wavelet transform and multirate signal processing.

A P Shivaprasad
Professor

Ph: 309 2656 email: aps@ece.iisc.ernet.in

Received B.E., M.E., and Ph.D. in Electrical Communication Engineering from I.I.Sc. in 1965, 1967 and 1972 respectively.

Currently working on multimedia communication systems, application of neural computation to instrumentation, and microprocessor based systems.

B S Sonde
Professor

Ph: 309 2276 email: sonde@ece.iisc.ernet.in

Received BE (Telecom) from Poona University, 1958; M.Sc(Engg.) (Advanced Electronics), Poona University, 1959; Ph D (Faculty of Engg.), Indian Institute of Science, Bangalore, 1963. Member, Academic Staff of the Department of Electrical Communication Engineering since 1964, where he is Professor from 1973. Short visits abroad on academic/scientific assignments: Tohoku University, Japan(1964), Stanford University, USA (1966), Swiss Federal Institute of Technology, Zurich Lausanne, Switzerland (1976, 79), Chulalongkorn University, Bangkok, Thailand (1984, 88, 89, 90).Ramlal Wadhwa Gold Medal, IETE (1978) Jaya Jayant Award for Teaching Excellence, IISc (1992) Distinguished Fellow, IETE (1982) Member, Electronics Commission, Government of India (1986-89) Chairman, ISHM-India Chapter (1985-93) President, IETE (India) (1992-94).

Currently working on microelectronics, integrated circuits, instrumentation, digital communication.

Mandavilli Satyam
Honorary Professor

Ph: 309 2279 email: msece@ece.iisc.ernet.in

Received B.E (Telecommunication) from Madras University (1958); M.E (Electronics), Indian Institute of Science, Bangalore (1960); Ph.D, Indian Institute of Science, Bangalore (1963). Joined the Institute in 1962.

Currently working in the area of microelectronics with functional approach as the main goal.

A Kumar
Emeritus Scientist

Received M.E (Microwave) from IISc. (1960); Ph.D (Antennas) from IISc. (1966).

Currently working in the area of Microstrip Patch Antennas.

D Narayana Dutt
Associate Professor

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Received B.E. from Bangalore University in 1967; M.E. (Distinction) and Ph.D. from IISc in 1969 and 1974. Worked earlier as Senior Research Assistant, Scientific Officer, Senior Scientific Officer and Assistant Professor in the Department. Visited AlFateh University, Tripoli, Libyaas Professor during 1985-87.

Currently working on digital processing of EEG(brain) signals with emphasis on spectral estimation, noise minimization and real time processing; EEG data compression and display; nonlinear dynamics and chaos; acoustics and speech signal processing.

Anurag Kumar
Associate Professor

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email: anurag@ece.iisc.ernet.in

Received B.Tech (EE) from I.I.T. Kanpur, 1977; Ph.D. from Cornell University, 1981. Member Technical Staff, Performance Analysis Department, ATT Bell Labs, Holmdel, N.J., 1981-1988; Faculty, ECE Department, Indian Institute of Science, Bangalore, 1988-. Senior Member IEEE Fellow IETE IETE's CDIL Award for a paper in Journal of IETE, 1993

Currently working on communication networking; in particular, modeling, analysis, optimisation, scheduling, and control problems, arising in communication networks and distributed systems.

Anamitra Makur
Associate Professor

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Received B.Tech.(Hons.) in Electronics and Electrical Comm. Engg. from I.I.T., Kharagpur, in 1985; M.S. and Ph.D. in Electrical Engg. from California Inst. of Tech., Pasadena, in 1986 and 1990. Joined this department as Asst. Professor in 1990.

Currently working on source coding (image, video, and data compression), image/video processing (halftoning, multidimensional filter design, television video processing, adaptive filtering), and channel coding (design of channel codes, decoding algorithms).

Utpal Mukherji
Associate Professor

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Received B.Tech. degree in Electrical Engg. from IIT, Bombay, in 1980, and S.M., E.E., and Sc.D. degrees in electrical Engg. and computer sc. from Massachusetts Institute of Technology in 1982, 1984, and 1986, respectively. Member of Technical Staff at ATT Bell Laboratories, Murray Hill, from 1986 to 1989.

Currently working on communication networks modelling and analysis. Activities include design of an experimental fiber-optic multi-access network.

T V Sreenivas
Associate Professor

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Received Ph.D. from Tata Institute of Fundamental Research, Bombay, 1981; M.E. (Distinction), Indian Institute of Science, 1975; B.E., Bangalore University, 1973. Scientist-C, Electronics Radar Development Establishment, Bangalore, 1982-85; Research Scientist, Norwegian Institute of Technology, Trondheim, Norway, 1986-87; Visiting Assistant Professor, Marquette University, Milwaukee, USA, 1988-90. Republic day award, Electronics Radar Development Establishment, 1984 Fellow, IETE, India, Senior Member, IEEE Signal Processing Society, USA, Member, Audio Engineering Society, USA.

Currently working on speech signal processing, auditory modelling, spectral estimation, speech/audio compression for bandwidth reduction, speech perception, hidden Markov models and neural networks for speech recognition, speech enhancement in noise, hi-fi audio systems, DSP architectures.

T S Vedavathy
Associate Professor

Ph: 309 2281 email: veda@ece.iisc.ernet.in
Received Ph.D from IISc, Bangalore in Microwave Antennas, M.Sc (Physics) from Bangalore University.

Currently working on high Tc superconducting thin films for microwave applications, microstrip antennas, radiation pattern synthesis for various applications, RF problems associated with cellular mobile communication, like mathematical modeling under multi scatterer environment and antennas suitable for mobiles.

Pallapa Venkataram
Associate Professor

Ph: 309 2387 email: pallapa@ece.iisc.ernet.in

Obtained Ph.D in Information Sciences from The University of Sheffield, UK. Worked for two years as a Deputy Manager (computers) at Hindustan Aeronautics Ltd. Has been a visiting scientist at University of Maryland, USA (April-May 1992), University of Montreal, Canada (June-July 1992), and University of Twente, The Netherlands (September-October 1995). IEEE Globecom'91 paper award, Received a diploma of distinguished visitor from UPAO, Truyillo,

PERU. Fellow IETE IETE CDIL'94 paper Award Member IEEE.

Currently working on protocol engineering by formal methods, AI applications in network management, wireless networks, multimedia systems.

D B Ghare
Principal Research Scientist

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Received Ph.D. (1967) from Pune University. Principal Research Scientist, 1985 - till date, IISc; Senior Scientific Officer, 1970 - 1985, IISc; Research Associate, 1968 - 1970, IISc; Asst Engr, 1967 - 1968, Semiconductors Ltd. Pune; Senior Research Fellow, 1967, N.C.L. Pune; Junior Research Fellow, 1963 - 1967, N.C.L. Pune. Best Paper Award and Gold Medal for the paper "Increasing Creapage Distance of High Voltage Insulators by Composite Designing" by Central Board of Irrigation and Power, 1977

Currently working on hybrid microelectronics compatible transducers technology, Microelectronic miniature sensors, Smart / intelligent sensors, Sensor signal processing conditioning circuits, MPPPHT (Microprocessor Programmed Periodic Pulsed Heating Technique) based sensor technology, Thick / thin film hybrid microelectronics materials, technology and devices, Composite materials for design of electronic devices.

Dinesh K Anvekar
Assistant Professor

Ph: 309 2746 email: dka@ece.iisc.ernet.in
Received B.E in Electronics Engineering with State Award and Gold Medal from Bangalore University, in 1979; M.E. in Automation with Distinction, in 1981; and Ph.D. in Microelectronics with Best Thesis Award, in 1990, both from the Indian Institute of Science. Has been a member of faculty of Electrical Communication Engineering, IISc, since 1982. Fellow of IETE; Senior Member of IEEE; IEEE Region 10 Paper Award, 1982; Visiting Scientist at State University of New York, 1986; Indo-US Fellowship 1993-94 for research at AT&T Bell Laboratories and IBM Watson Research Center, USA KAAS Young Scientist Award in 1994 ; Two US International Patents for New Handover Techniques, 1995 ,1996; First author of Tata McGraw Hill book on Electronic Data Converters.

Currently working in the areas of digital communication, microelectronics, and intelligent instrumentation. Some of the recent activities include development of new techniques for nonlinear ADCs, multimicroprocessor system design and implementation, handover and channel assignment techniques in mobile cellular communication systems, and fuzzy logic architectures.

K V S Hari
Assistant Professor

Ph: 309 2745 email: hari@ece.iisc.ernet.in

Received Ph.D from University of California, San Diego (1990); M.Tech, I.I.T. Delhi (1985); B.E., Osmania University, Hyderabad (1983); Scientist, Defence Electronics Research Laboratory, Hyderabad (1985-87); Scientist, Osmania University, Hyderabad (1991-92); Faculty, Department of ECE, Indian Institute of Science (1992 -); Visiting Faculty, Department of Signals, Sensors Systems, Royal Institute of Technology, Stockholm (Jul-Sep 1995)

Currently working on application of signal processing techniques to mobile communication, higher-order spectrum analysis, time-frequency representations, active sound control.

James Jacob
Assistant Professor

Ph: 309 2282 email:james@ece.iisc.ernet.in

Received B.E. and Ph.D degrees in Electronics and Communications from IISc in 1983 and 1988 respectively. Joined the faculty of ECE Department in May 1988.

Currently working on the development of efficient algorithms for logic synthesis, test generation and fault simulation of large digital circuits. Work is also in progress on developing switching theory based techniques for digital data compression.

Kumar N Sivarajan
Assistant Professor

Ph: 309 2658 email: kumar@ece.iisc.ernet.in

Received Ph.D. from California Institute of Technology (1990); M.S., California Institute of Technology (1988); B.Tech., I.I.T. Madras (1987). Assistant Professor, IISc (1994—); Research/ Scientific Staff Member/Postdoctoral Fellow, IBM T.J. Watson Research Center, Yorktown Heights, NY (1990—1994).

Currently working on communication networks: all-optical, mobile/cellular and ATM (high-speed packet-switched) networks with emphasis on performance analysis, network architecture and design, and network algorithms.

Malati Hegde
Senior Scientific Officer

Ph: 334 0855, 309 2387
email: malati@ece.iisc.ernet.in

Received Ph.D from the Indian Inst. of Technology, Kanpur

Currently working on computer networks.

M K Ravishankar
Senior Scientific Officer

Ph: 309 2743

Received M.Sc (Engg.) from Indian Institute of Science.

Currently working on devices.

M V Srinath
Senior Scientific Officer

Ph: 309 2743

Received B.E. and M.E. from IISc.

Currently working on electronic circuits and television field.

Victor Anand Raj
Scientific Officer

Ph: 309 2745 email: victor@ece.iisc.ernet.in

Received M.E. Degree (ECE) from Indian Institute of Science, Bangalore.

Currently working in the area of multimedia.

T Badrinarayana
Scientific Officer

Ph: 309 2279 email: badri@ece.iisc.ernet.in

Received M.Sc from Sri Venkateswara University, M.Sc (Engg.) from Indian Institute of Science, Bangalore.

Currently working on electronic devices, superconducting devices, optoelectronics.

S V Gopalaiah
Scientific Officer

Ph: 309 274 email: svg@ece.iisc.ernet.in

Received M.Sc.(Physics), Bangalore University, 1981; M.Sc. (Engg.), Indian Institute of Science, 1995. Worked as Scientific Assistant and Technical Officer since 1981.

Currently working on voice/data integration, dynamic channel allocation, microcontrollers, GPIB interfacing, PALs.

K Sivashankara Reddy
Scientific Officer

Ph: 309 2279 email: kssreddy@ece.iisc.ernet.in

Received M. Tech from Indian Institute of

Technology, Kharagpur.

Currently working on devices.

Anandi Giridharan
Technical Officer

Ph: 309 2282 email: anandi@ece.iisc.ernet.in

Received B.E. Degree in Electrical Engineering from Bangalore University in 1988.

Currently working in the area of communication networks, security management.

E S Shivaleela
Technical Officer
Ph. 309 2283 email: lila@ece.iisc.ernet.in

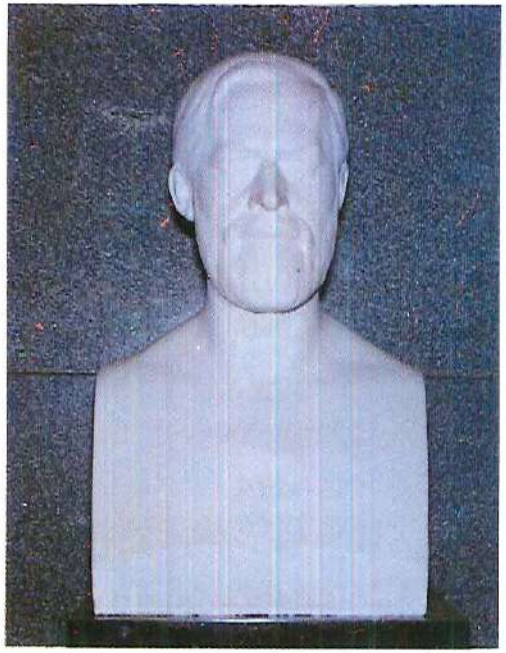
Received B.E. Degree in ECE in 1987 from Mysore University.

Currently working in the areas of optical communication and integrated optics .

ECE LABORATORIES

Acoustics

Devices

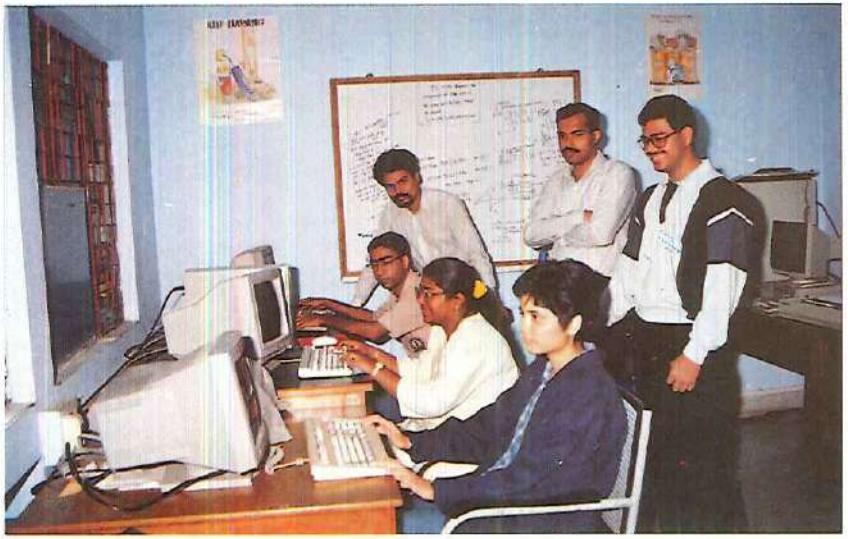


Bust of Heinrich Hertz in ECE Foyer

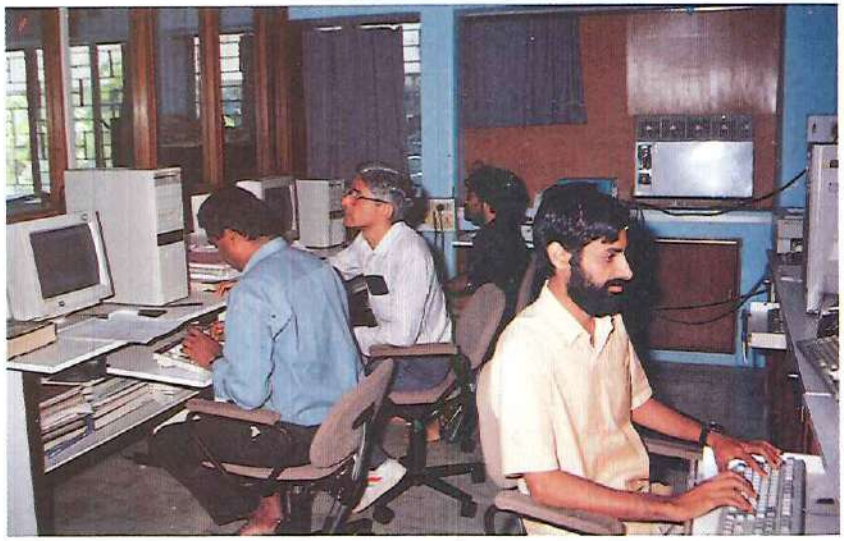
ECE STAFF & STUDENTS AT WORK

Devices Laboratory

Microwave Laboratory



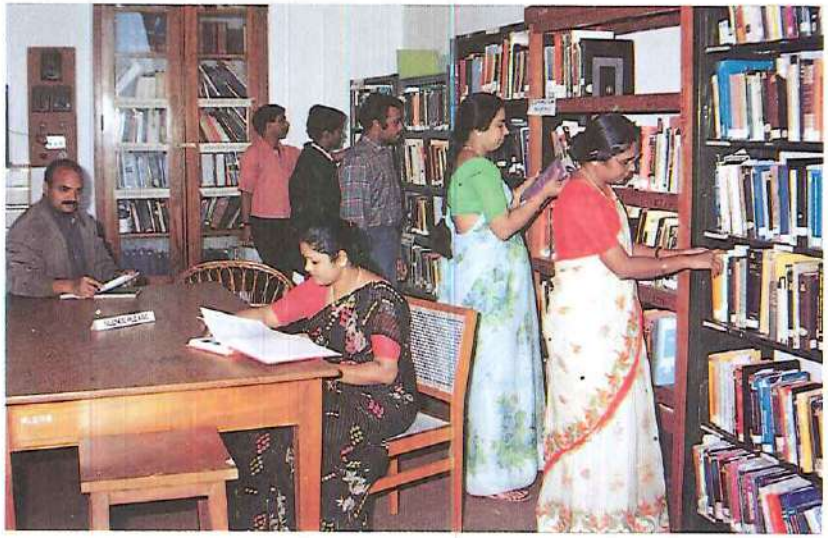
Visual Communication Laboratory



Acoustics Laboratory

ECE STUDENTS & STAFF AT WORK

Microprocessor Laboratory



Library

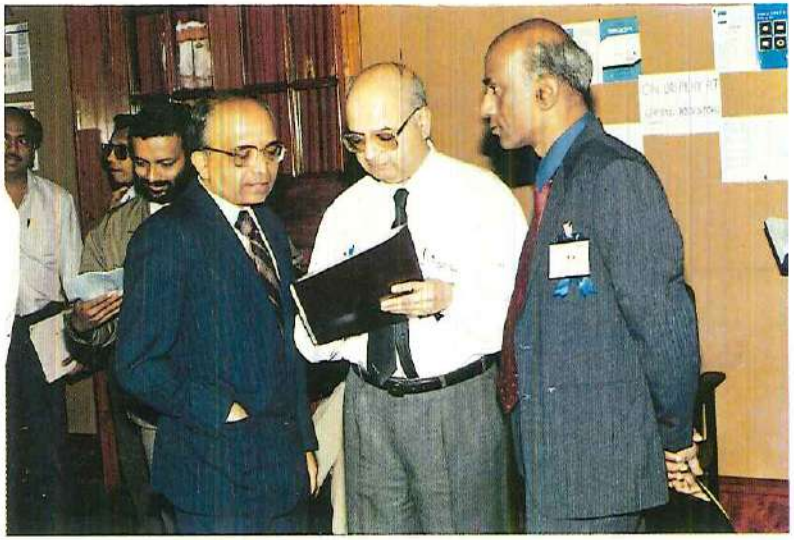
SWEET MEMORIES

Silver Jubilee Reunion of BE (ECE/ET) 1964 Batch

CONFERENCE MEMORIES - CEOT '94

Inaugural address by Prof. U R Rao, Chairman, ISRO

Valedictory address by Prof. C N R Rao, Director



Faculty with Delegates

Attentive Audience

4. ECE : VISION 2000

1. INTRODUCTION

Visualizing the technology map of the future is a difficult task with rapid changes in technology taking place almost every year. New directions in ECE technology in the next millenium and the challenges ahead have been proposed by an EEE Experts Committee (Box A) recently. This can form the basis for a future vision for the Department. Following this, an attempt is made to look into the future and contemplate on the role of our Department in the next few years.

2. FUTURE TRENDS

Communication between humans-machines-humans will be the prime objective of society. To realize this, Personal Mobile Communication will be the major thrust of research activity all over the world. Information Technology will result in the home computer becoming an 'infotainment' device. Broadcast communication of Radio and TV will go digital with better quality. It will not be long before one can observe all the multimedia enter the communication arena in the future microcellular environment. We can foresee the interconnected computer networks replaced by such wireless communication networks which will enable not only the advancement of the cellular phones, but also linking of all the multimedia. Advances in microelectronic and optical device technology will yield high performance computing power which will enable sophisticated signal processing systems to be designed for the real world. Digital Signal Processing (DSP) technology will become omnipresent. Philosophically, discplines will become more and more inter-dependent.

3. TECHNOLOGY FOR COMMUNICATIONS

3.1 The major thrusts in 'wired' communication will be the use of Optical fibre, use of existing wired local loop for digital local loop, use of existing Cable TV (CATV) cable for bidirectional digital transmission. Wireless communication for personal communication will include the use of new signal processing techniques for efficient use of the available meagre bandwidth. Switching systems to realize this will include Fast Ethernet for shared medium, ATM cell switching for local to wide area networks. Asynchronous Transfer Mode (ATM) based Broadband Integrated Services Digital Networks (B-ISDN) and Internet type networks will be the most widely used. In the area of antennas for mobile communications, the chief interest of research will be on the synthesis of microwave antenna arrays for mobile communications. The demands here are to achieve a specified radiation pattern with high gain and high efficiency transmit-receive antennas at the base station to provide channel allocation to the mobile phones on one hand, and on the other, to fabricate compact, conformal, highly sensitive transmit-receive antennas to be placed inside the mobile phones, which will be the future trend in the next five years.

3.2 One of the RF problems in the area of cellular telephony seems to be a rigorous analysis and estimation of scattered signals in multipath environments. Diversity reception not only at the base station but also at the mobile handset may be expected to be the solution for the above problem. For instance, the pagers and cellular phones of the recent days used for mobile communications mostly utilize the wire (dipole) antennas and loop antennas, which in future are expected to be replaced by the low- profile, thin and compact microstrip antennas. These will employ stacked structures of microstrip patches, especially microstrip ring antennas with optional combination with patches of other structures. More in-depth and very precise design and analysis accounting for the radiation patterns, the directivity and the other important antenna characterisitics will be evolved. Another area of prime interest will be bandwidth enhancement maintaining higher gains by using newer orientation of microstrip elements in different array configurations.

3.3 A major requirement for the near future seems to be the evolution of CAD software packages to realize the required specifications, particularly in the area of cellular mobile communications. Moreover, we can foresee the exploitation of the higher ends of microwave frequencies which will greatly reduce the size of the antennas required. The frontier regions of the microwaves under research, especially the millimeter range of frequencies will be utilized and no longer will they continue to remain the frontier regions. The high power sources that are required for generation of millimeter range signals may be expected to be a goal for achievement in the next few years. In addition to the above, a newer dielectric substrate which has very high breakdown voltage may be evolved which would enable the microstrip antennas to effectively act as a transmitter also, besides its present use for receiving the microwaves. These two achievements put together may lead to a stage wherein the huge parabolic dishes will be replaced by small compact microstrip patch antennas and their arrays, since the millimeter wave frequencies may be expected to be

deployed for all space and satellite communications in the future.

3.4 Digital Signal Processing (DSP) technology is centered around DSP processors. Hardware and software DSP tools will play a prominent role in the implementation of any complex system dealing with sampled signals. As advances in DSP hardware take place, more efficient software tools to assist the developer will be developed reducing the cycle time for developing a DSP product.

3.5 The Microelectronics Devices Laboratory of the ECE Department evolved from simple facilities for vacuum tube fabrication to the present stage which has basic facilities to carry out basic research work to conceive new electronic devices and verify their performance based on vacuum, gas filled liquid state and the various disciplines of solid state. A vision of the Laboratory is to build up its facilities to such a level wherein any type of device, new or old, can be synthesized and fabricated with teams of academic staff and scores of students working with the goal of conceiving, developing new devices and technologies which are simple, elegant and provide direct solutions to the multitude of old and new problems of communication systems.

3.6 Some major application areas that are envisaged to receive primary attention include personal communication services over wireless medium; multimedia services over wireless networks; High Quality broadcast systems like Digital Audio Broadcasting, High Definition TV and Direct Broadcasting Satellite Systems. As the density of the global WEB is expected to increase tremendously, applications around the world wide web (WWW) will become a major focus of activity.

4. WHAT SHOULD ECE DO?

4.1 The prime objective of the Department is to maintain excellence in research and advanced level instruction/training. The goal of ECE should be to stay relevant to the needs of the electronics and telecom industry in India while pursuing excellence in research and academic work. We need to balance these goals but that should not be difficult since the former (staying relevant) only provides direction to the scope of research and academic programme and does not necessarily impact the latter (excellence).

4.2 Over the next five years, this means that we pursue research and academic work in the areas of personal mobile telecommunications and networking What do we do using the Internet which is now connected to almost every computer in the world, how do we do it well, what are the problems we face, how do we solve them, what are the special problems, if any, in the Indian context?; Such questions can help us in identifying directions for our future activity. Over the next ten years, we do not know what new areas/ technologies will emerge as the important ones; but the onus will be on us to identify these areas (considering technology directions/challenges such as those in Box A) early on and understand them well enough before the new technologies are ripe for implementation.

4.3 We have to reevaluate what we are training our students for. Should the training of the students be driven by faculty research interests or what the outside world needs and their own career goals? Except for a few students who will end up in advanced theoretical research, the research should be driven from strong practical considerations but carried out with the best of analytical and experimental tools.

4.4 Due to a gradual but firm change in the central Government funding scenario, the Institute will have to earn most of its finances soon. Some engineering departments including ECE have the potential to take the lead in this respect. Therefore, a welcome trend for ECE is to have increased emphasis on industry-oriented activities. This would mean teaching would be strengthened again, and it would be specifically tuned to the needs of the industry (which is likely to include more laboratory training and wider coverage including theory and implementation). This would also mean research would be directed towards present-day problems rather than mere publication-oriented fundamental research. These directions of teaching and research are but welcome changes, since they effectively serve the society more than what is being done at present. Further, the tremendous advancement and globalization of Indian industry during the past decade has also reduced the gap between what academia does and what industry does. Fall-outs of this industry-oriented trend would be sacrificing part of individual freedom by the faculty, staff and students of the Department towards a larger goal, and strengthening of group rather than individualistic activities. The launching of the Industrial Associateship Programme in 1996 to bring industry closer to the Department is indeed a welcome first major step in this connection.

4.5 The faculty and students of ECE as well as sister entities often feel the need to work together. Proof of this trend is seen in one current joint teaching programme and in two more future joint

A. NEW DIRECTIONS IN ECE TECHNOLOGY - MAJOR CHALLENGES

- To be reachable at any time, anywhere through worldwide personal communication systems (PCS) and wireless/fiberless communications;
- To have instant access to all information through databases, high speed links, flat-panel displays and interfaces;
- To be present at any time, anywhere through virtual presence and reality;
- To enjoy abundanat, clean, safe and affordable energy;
- To travel faster and more safely over intelligent highways;
- To work in paperless offices;
- To not carry any cash and use electronic purse or wallet.

Reference : IEEE Spectrum, vol.30, no.1, Jan.1993, pg.81

ECE Golden Jubilee Organizing Committee.

teaching programmes, as well as in other joint activities including sponsored research, seminars, and conferences proposed. It is expected that ECE would, in the future decade, work more closely with the Departments of Electrical Engineering and Computer Science & Automation, and with the Centres like CEDT and SERC. Further, the merging of apparently different fields would be seen within the Department itself, with groups that now possess separate identity merging. Consequently, the training provided by the Department would be wider in technical aspects. You won't hear phrases like "I work on theory, he's an experimentalist." Everyone would be a theorist and would conduct experiments, too. You won't distinguish a hardware engineer from a software engineer. Rather, the individual distinctions would be based on the area of specialization.

5. THRUST AREAS FOR RESEARCH & ACADEMIC WORK:

The following thrust areas for research and academic work are now proposed following box A and the above line of thinking.

Communications:
Broadband and Wireless Networks - Performance analysis, network planning.

Mobile Cellular Communication - Channel Assignment, Handover Management.

Microelectronics:
ASIC based communication hardware development, Intelligent Instrumentation, CAD of microelectronic circuits and systems.

Signal Processing:
Speech, audio, video and data compression with applications to multimedia and mobile cellular communication. Space-Time communication systems with emphasis on Antenna array signal pressing for mobile cellular communication.

Compiled and edited by:
Dr. D K Anvekar and K V S Hari
The assistance received from faculty, colleagues and students is greatly acknowledged.

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