Intake, Entry, Progression, Programme structure and Detailed Syllabus
of the

MTech Programme in Electronics and Communication Technology

with **a**pproval from the AICTE (All India Council for Technical Education) under Gauhati University

October, 2009

Introduction

The Department of Electronics and Communication Technology (formerly Department of Electronics Science), since its inception, has been offering the MSc Electronics Science programme adhering to its laid objectives. Initially the department was started in the building of the department of Physics and it was subsequently shifted to its present location in early 1996. Some of the major achievements of the department in the past five years are enlisted below:

- The MTech programme in Electronics and Communication Technology offerd by the department from 2009-10 min 2-year format and from 2008-09 in four year integrated/ dual degree format has been approved by AICTE for two years.
- The department has become a part of Faculty of Technology from 2008-09.
- The department has received financial assistance under FIST programme of the Department of Science and Technology, Govt of India in 2001 and has been benefited considerably while setting up of an Advanced Computational lab and partial modernization of its existing infrastructure.
- The Gauhati University has (in 2005-06) recognized the MSc (Electronics Science) course to be equivalent to the BE (Electronics and Telecommunication Engineering) course offered by it for technical jobs.
- The department also has the honour of housing CDAC's Project Garuda Center of Gauhati University which is a partner institute in the CDAC's Garuda Grid Computing Initiative.
- The department currently is running four externally funded research projects amounting to nearly Rs. 50 lac.s.
- The department has been recommended by the NAAC as follows:

  University leadership is invited to focus its attention to the Department of Electronics for meeting the urge of its faculty and students to scale heights for reaching the category of the Major departments, since they have the potential for growth and are highly relevant to meet the changing needs of time. (Ref. NAAC Report No. GU/QAC/GC/1/2000/161-77 dtd. 16.11.01).

Keeping in mind the fast changing scenario of Electronics Technology the department is constantly evolving measures to keep itself updated through limited resources available by

- Making frequent revisions of the syllabus,
- Innovative teaching methods,
- Hiring experts and peers in the field to deliver lectures and evaluate students' performances in final examinations,
- Design based project works,
- Computer-oriented learning through the use of subject specific software etc.

The department has laid a road map for the next few years which includes a number of major changes in its present structure and related infrastructure which are essential to make the students passing out of the department remain in the reckoning in the ever shrinking job-scenario. The department visualizes its **road map** for the next few years as:

- Initiation of a one year Post Graduate Diploma in Electronics Science and Technology under Gauhati University as a distance learning programme.
- Initiation of short term career oriented courses under a separate unit of the department to provide need based vocational training to the educated unemployed of the state.
- Offering design and development consultancy on a regular basis to the industry to improve the academic- industry linkage.
- Providing impetus to a strong R&D drive in certain leading areas like-
    - Nano-Technology,
    - Quantum dots,
    - Web based applications,
    - Opto- Electronics,
    - Sensor development,
    - Artificial Neural Networks applications,
    - Computer Vision, Pattern Classification and Recognition,
    - VLSI Design

The infrastructure facilities primarily the laboratories needs to be revamped as early as possible to make the efforts be in tune to meet the challenges to be posed by the road map laid by the department. The department will also need a new multistoried RCC structure as an extension to the present one to meet the necessities of the new courses, house new laboratories and related facilities and setup improved hostel accommodation etc.

This department, being the only department in the entire NE region offering M.Sc Electronics Science course, strongly feels the necessity to open new vistas of teaching and learning of Electronics with the introduction of MTech (and BTech) programme.

The MSc Electronics Science course being run by the department has a syllabus and a course structure with all the pre-requisites to meet the industry needs. But an inclination of the private sector and some public sector towards BTech / MTech degree holders places the students obtaining the MSc Electronics Science degree in a precarious position. This is an all-India phenomenon. Hence, the department wants to make a change by converting the present MSc Electronics Science course into an MTech programme with an extended form containing contemporary discourses of study.

The BTech programme- introduced from 2009-10 under the newly constituted Institute of Science and Technology, Gauhati University can be seen to be a launch pad of an extended platform for systematic study of Electronics in the under graduate level. Very few similar courses are available in the NE region which has lead to the migration of a large chunk of the students of the region to other parts of the country in pursuit of such courses. It has amounted to severe financial loses to the entire region. The introduction of such a course will be a small measure towards arresting this migration. It will help to produce properly trained manpower to meet the needs of the industry and related sectors that has relevance to Electronics. The objective is to place the students in a better position with respect to job placements. Many times the title of the degree obtained plays a crucial role. This has been a fact observed by the department very often. Hence, this change over is essential to help the students be better equipped to meet the needs of the changing times.

The following pages present the details of the proposed MTech programme in Electronics and Communication Technology. The details are like entry, progression, course structure examination and detailed syllabus.

Master of Technology (MTech) in Electronics and Communication Technology (AICTE Approved vide letter no F. No 06/07/Assam/Engg./2009/01 May 27, 2009.).

Objective:

- To offer a programme for systematic study of Electronics and related technology at the post graduate level with universal acceptability and recognition.
- To provide career advancement to students through a programme offering contemporary know-how and skills to students of Assam and NE region.
- To lay the foundation of technology oriented research as a means of progression and thereby contribute to the development of the region.
- To provide the students of the NE region an opportunity to have a viable option to take up academic pursuit as a means of career advancement.
- To contribute towards generation of quality manpower to meet the needs of the industry and related sectors that has relevance to Electronics.

Intake: 18 (eighteen)

Categories

(I)	**REGULAR (FULL-TIME)** These are students who will attend course work full time for their M. Tech degrees. The duration will be 2-years. The admission shall be from the BE / BTech / MSc stream with a minimum CPI / CGPA of 5 or 50% in the final examination. A full-time student during the programme cannot engage himself/ herself in any form of activity such as employment, enrollment into other programmes/ courses etc. Maximum duration of the programme- Four Years.
(II)	**PART-TIME:** This category refers to the candidates who are local (from areas in and around Guwahati) and professionally employed personnel (including staff employed in sponsored projects or in other capacity in the University), who can attend classes while continuing with professional commitments. These candidates should be able to attend regular classes as per the schedule of the programme (s). Those who are from outside of the University, must be regular employee of an academic institution / R& D organization / govt / PSU establishment / industry or reputed national or international industry / organization related to the field of study with at least two years of experience at the time of admission and be engaged in professional work in the discipline in which admission is sought. No financial assistance will be available to such students. A No Objection certificate from the Head of the Institution / Organization in which he / she is employed must be enclosed at the time of application clearly stating that he would be released / allowed to pursue courses as per the schedule of the University. Entry Qualification as in category (I). Minimum duration three years and maximum duration- five Years.
(V)	**MTech by Research** Candidates who have already completed MPhil / PhD in the related subject from a UGC recognized university after completion of MSc can be considered under this category. The minimum duration for the programme will be three semesters for full time and five semesters for part-time. The maximum duration of this category in full time is three years and for part-time it is four and half years. Such candidates upon admission will require attending course work as outlined at the time of admission. For part-time category students the rules will be as in Category III. The MTech by research programme shall have class-work of around 20 to 24 credits.

Eligibility:

- MSc in relevant disciplines like Electronics Science, Instrumentation.
- BE / BTech in ECE, EE, Instrumentation.
- Candidates with a valid GATE qualification shall be given preference.

Selection Procedure: Selection will be on the basis of a selection test held among the students fulfilling the eligibility criteria.

Examination and evaluation:

Though absolute marking should be the guiding principle of evaluation of performance of students, the performance measure should be reported in terms of grades as per the following classification:

Conversion of marks to Grades:

Actual marks secured by a group of candidates are converted into Relative Percentile (R) before conversion into Relative Letter Grades. The maximum actual marks (i.e. highest mark) (M) secured in a particular group is converted into 100% and other actual marks (A) secured by the students of the same group are converted to the relative percentile

R= Relative Percentile

M = Maximum (Highest) marks in the class.

A= Actual marks of a student who passed i.e. if the actual mark is not less than 30%.

b. Conversion Table: The letter grades and the corresponding grade points are as follows :

Range of Relative percentile	Letter Grades	Grade point
90-100	A	10
75-89	B	8
55-74	C	6
40-54	D	4
30-39	E	2
below 30%	F	0

In addition, there shall be one transitional grades 'I'' used by the instructors. The teacher of a subject may award the grade 'I' to a student if the latter was compelled to absent him / her- self from the end semester examination on account of:

1. Illness or accident which disabled him from appearing at the examination.

2. A calamity in the family at the time of the examination, which, in the opinion of the Institute, required the student to be away from the campus.

A student will be eligible for the award of grade 'I' only if his / her attendance at classes and performance in other components of assessment are complete and satisfactory. Evaluation is based of the specific clauses mentioned in the programme-specific University Ordinance.

In case of
(i) Theoretical subjects, the evaluation will be based on teachers' assessment, quizzes, mid semester examination and end semester examination. a. Class-tests or quizzes will be organized by the teachers concerned. This will carry 20% weightage. b. The mid-semester examination will be conducted by the departments. The mid-semester examination will carry 40% weightage. The results of performance of the students in the mid semester examination shall be announced by the teachers of the subjects concerned within a fortnight of the date of examination. c. The end-semester examination will be conducted centrally by the Controller of Examination of the University every semester. The end-semester examination will consist of one paper of each of the courses. Each of the papers will be of hundred marks and be of three hours duration. The end –semester examination will carry 40% weightage.
(ii) For sessional subjects (Laboratory / Workshop / Field Work etc.), the evaluation will be on the basis of continuous evaluation and end semester examination / viva. A record is to be maintained of the evaluation done of each session of sessional subjects (Laboratory / Workshop / Field Work etc.). The evaluation will be done by the instructor/ teacher concerned with inputs from Teaching / Lab Assistants. a. End Semester Examination will carry 50% weightage and b. Marks allotted under continuous evaluation will carry with 50% weightage

- The MTech programme in Electronics and Communication Technology offered by the department from 2009-10 in the 2-year format has been approved by AICTE. The syllabus and the course format has been approved vide resolution No GU/M/AR/New/Courses/08/64 dated 12-1-2008 of the Academic Council, Gauhati University. The Executive Council of the University granted permission to start the 4-year dual degree MTech Programme vide Resolution No 2008/9 (7)/116 dated 31-07-2008.

Programme Structure:

MTech in Electronics and Communication Technology (4-semesters)

Semester	Course Code	Course	L	T	P	C
1	EL 354	Digital Signal Processing	2	2	3	5
	EL 592	Linear Algebra and Random Process	2	2	0	4
	EL 593	Satellite Communication	2	2	3	5
	EL 594	VLSI Technology	2	2	3	5
	EL 477	Seminar & Term Paper	0	5	0	5
	Semester Total		**8**	**13**	**9**	**24**
2	EL 366	Mobile Communication	2	3	0	5
	EL 367	DSP Processor	2	2	3	5
	EL 5103	Statistical Signal Processing	2	2	3	5
	EL 5104	Digital Image Processing	2	3	0	5
	EL 5105	VHDL & Digital Design	2	1	3	4
	Semester Total		**10**	**11**	**9**	**24**
3	EL 6111	Elective	3	3	0	6
	EL 6112	Project Phase 1	0	15	9	18
	Semester Total		**3**	**18**	**9**	**24**
4	EL 6121	Project Phase II	0	18	18	24
	Semester Total		**0**	**18**	**18**	**24**

EL 6111	**Elective**	A. Communication Networks
		B. Advanced Processor Architecture
		C. Embedded Systems
		D. Bio Medical Signal Processing
		E. Robotics
		F. Speech Processing
		G. Optical Sensors
		H. Information Theory
		I. Soft Computing
		J. Neural Networks
		K. Advanced Photonics
		L. Advanced Antenna Design
		M. Bio-Electronics
		N. Data Security
		O. Computer Vision
		P. Bluetooth
		Q. Bio-Informatics
		R. Optical Communication

Detailed Syllabus:

Semester One:

Semester	Course Code	Course	L	T	P	C
1	EL 354	Digital Signal Processing	2	2	3	5
	EL 592	Linear Algebra and Random Process	2	2	0	4
	EL 593	Satellite Communication	2	2	3	5
	EL 594	VLSI Technology	2	2	3	5
	EL 477	Seminar & Term Paper	0	5	0	5
	Semester Total		**8**	**13**	**9**	**24**

Course Code	Course	L	T	P	C
EL 354	Digital Signal Processing	2	2	3	5

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

Course Code	Course	L	T	P	C
EL 592	Linear Algebra and Random Process	2	2	0	4

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;
2. Matrix Analysis- . R. Horn and C. Johnson, Cambridge U.P;
3. Probability, Random Variables and Stochastic Processes- A. Papoulis, McGraw-Hill;
4. Probability, Random Variables and Estimation Theory for Engineers- H. Stark and J.W. Woods, PHI

Course Code	Course	L	T	P	C
EL 593	Satellite Communication	2	2	3	5

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/No

Unit 5 Satelite Applications

INTELSAT Series, INSAT, VSAT, Remote sensing, Moble 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
2. Satellite Communication Systems Engineering- Wilbur L.Pritchard, Hendri G.Suyderhood, Robert A. Nelson, Prentice Hall;
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

Course Code	Course	L	T	P	C
EL 594	VLSI Technology	2	2	3	5

Unit 1: Introduction

Evolution of integrated circuits, Advantages of integration, Basics of IC processing steps: Wafer preparation, Oxidation diffusion, Ion implantation, Dielectric & polysilicon film deposition, Metallization;

Unit 2: Advanced Processing Techniques

Electron beam lithography, X-ray lithography, Relative ion etching, Plasma etching; Process simulation: Introduction, Ion implantation, diffusion & Oxidation; VLSI process integration- CMOS & NMOS process integration, MOS memory IC technology, Bipolar IC technology; Advance techniques & packaging: of VLSI devices; Package type, Packaging design considerations;

Unit 3: Digital IC Design

V-I Characteristics of MOS circuits, MOS switch and inverter, latch-up in CMOS inverter; sheet resistance and area capacitances of layers, wiring capacitances; CMOS inverter properties - robustness, dynamic performance, regenerative property, inverter delay times, switching power dissipation, MOSFET scaling - constant-voltage and constant-field scaling;

Dynamic CMOS design- steady-state behavior of dynamic gate circuits, noise considerations in dynamic design, charge sharing, cascading dynamic gates, domino logic, np-CMOS logic, problems in single-phase clocking, two-phase non-overlapping clocking scheme;

Subsystem design- design of arithmetic building blocks like adders - static, dynamic, Manchester carry-chain, look-ahead, linear and square-root carry-select, carry bypass and pipelined adders and multipliers - serial-parallel, Braun, Baugh-Wooley and systolic array multipliers, barrel and logarithmic shifters, area-time tradeoff, power consumption issues; designing semiconductor memory and array structures: memory core and memory peripheral circuitry.

Unit 4: Yield & reliability in VLSI circuit

Mechanism of yield loss in VLSI reliability requirement for VLSI, Mathematics of failure distribution reliability & failure rates, Failure mechanism; VLSI simulation using P-SPICE & Model-simulation software;

Suggested reading

1. VLSI technology- S. M Sze, McGraw Hill.
2. VLSI fabrication principles- S.K Gandhi, John Wiley & sons.
3. Physics & Technology of semiconductor devices- A.S.Grove, Wiley, New York
4. Microelectronics- J. Millman & Gurbial , Tata McGraw Hill.
5. Digital Integrated Circuits- A Design Perspective- J.M. Rabaey, A. Chandrakasan & B. Nikolic, PHI;
6. Basic VLSI Design- D.A. Pucknell and K. Eshraghian, PHI;
7. Introduction to VLSI Design- E.D. Fabricius,McGraw Hill,
8. Principles of CMOS VLSI Design- Weste and Eshraghian, Pearson Education;

Course Code	Course	L	T	P	C
EL 477	Seminar & Term Paper	0	5	0	5

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.

Second Semester:

Semester	Course Code	Course	L	T	P	C
2	EL 366	Mobile Communication	2	3	0	5
	EL 367	DSP Processor	2	2	3	5
	EL 5103	Statistical Signal Processing	2	2	3	5
	EL 5104	Digital Image Processing	2	3	0	5
	EL 5105	VHDL & Digital Design	2	1	3	4
	Semester Total		**10**	**11**	**9**	**24**

Course Code	Course	L	T	P	C
EL 366	Mobile Communication	2	3	0	5

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
3. Mobile communications Engineering: Theory And Applications- W.C.Y.Lee McGraw Hill,
4. Mobile Communications- Schiller, Pearson Education
5. Wireless Communications and Networks -Stallings, Pearson Education
6. Wireless Communication Systems -Wang and Poor, Pearson Education

Course Code	Course	L	T	P	C
EL 367	DSP Processor	2	2	3	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

1. Architectures for Digital Signal Processing- P. Pirsch, John Wiley
2. Digital Signal Processing in VLSI- R. J. Higgins, Prentice-Hall,
3. Texas Instruments TMSC5x, C54x and C6x Users Manuals.
4. Analog Devices ADSP 2100-family and 2106x-family Users Manuals.
5. VLSI Digital Signal Processing Systems- K. Parhi,John Wiley;
6. Digital Signal Processing for Multimedia Systems- K. Parhi and T. Nishitani: Marcel Dekker;
7. Digital Signal Processors- Kuo and Gan, Pearson Education;

Course Code	Course	L	T	P	C
EL 5103	Statistical Signal Processing	2	2	3	5

Unit 1: Discrete Random Signal Processing

Discrete Random Processes, Expectations, Variance, Co -Variance, Scalar Product, Energy of Discrete Signals -Parseval's Theorem, Wiener Khintchine Relation - Power Spectral Density - Periodogram – Sample Autocorrelation - Sum Decomposition Theorem, Spectral Factorization Theorem - Discrete Random Signal Processing by Linear Systems - Simulation of White Noise - Low Pass Filtering of White Noise;

Unit 2: Spectrum Estimation

Non-Parametric Methods-Correlation Method - Co-Variance Estimator - Performance Analysis of Estimators - Unbiased, Consistent Estimators-Periodogram Estimator-Barlett Spectrum Estimation-Welch Estimation-Model based Approach - AR, MA, ARMA Signal Modeling-Parameter Estimation using Yule-Walker Method. Spectral factorisation theorem. Signal Modelling: AR, MA and ARMA models. Parameter Estimation- principle of estimation and properties of estimates, the methods of maximum likelihood, Baysian estimation

Unit 3: Linear Estimation And Prediction

Maximum likelihood criterion-efficiency of estimator-Least mean squared error criterion -Wiener filter-Discrete Wiener Hoff equations-Recursive estimators-Kalman filter-Linear prediction, prediction error-whitening filter, inverse filter-Levinson recursion, Lattice realization, and Levinson recursion algorithm for solving Toeplitz system of equations.

Unit 4: Adpative Filters

FIR adaptive filters-Newton's steepest descent method - adaptive filter based on steepest descent method- Widrow Hoff LMS adaptive algorithm- Adaptive channel equalization-Adaptive echo chancellor-Adaptive noise cancellation-RLS adaptive filters-Exponentially weighted RLS-sliding window RLS-Simplified IIR LMS adaptive filter. Kalman 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

1. Statistical Digital Signal Processing and Modeling- Monson H.Hayes, John Wiley
2. Digital Signal processing - Proakis, Pearson Education
3. Adaptive Filter Theory- Haykin, Pearson Education
4. Statistical Signal processing- Srinath, PHI

Course Code	Course	L	T	P	C
EL 5104	Digital Image Processing	2	3	0	5

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

1. Fundamentals of Digital Image processing- A. K. Jain, Pearson Education
2. Digital Image Processing- R. C. Gonzalez and R. E. Woods, Pearson Education
3. Digital Image Processing using MATLAB- R. C. Gonzalez , R. E. Woods and S. L. Eddins, Pearson Education
4. Digital Image Processing and Analysis- Chanda and Mazumdar, PHI
5. Digital Image Processing- Annadurai and Shanmugalakshmi, Pearson Education
6. Digital Image Processing- Castleman, Pearson Education
7. Digital Image Processing- Pratt, John Wiley

Course Code	Course	L	T	P	C
EL 5105	VHDL & Digital Design	2	1	3	4

Course Objective
The course provides an exposure to different methods of VLSI design and the principles behind such design.

Module1: Introduction
Evolution of integrated circuits, Advantages of integration, Basics of IC processing steps: Wafer preparation, Oxidation diffusion, Ion implantation, Dielectric & polysilicon film deposition, Metallization;

Module 2: Advanced Processing Techniques
Electron beam lithography, X-ray lithography, Relative ion etching, Plasma etching;. Process simulation: Introduction, Ion implantation, diffusion & Oxidation; VLSI process integration- CMOS & NMOS process integration, MOS memory IC technology, Bipolar IC technology; Advance techniques & packaging: of VLSI devices; Package type, Packaging design considerations;

Module 3: Digital IC Design
V-I Characteristics of MOS circuits, MOS switch and inverter, latch-up in CMOS inverter; sheet resistance and area capacitances of layers, wiring capacitances; CMOS inverter properties - robustness, dynamic performance, regenerative property, inverter delay times, switching power dissipation, MOSFET scaling - constant-voltage and constant-field scaling;
Dynamic CMOS design- steady-state behavior of dynamic gate circuits, noise considerations in dynamic design, charge sharing, cascading dynamic gates, domino logic, np-CMOS logic, problems in single-phase clocking, two-phase non-overlapping clocking scheme;
Subsystem design- design of arithmetic building blocks like adders - static, dynamic, Manchester carry-chain, look-ahead, linear and square-root carry-select, carry bypass and pipelined adders and multipliers - serial-parallel, Braun, Baugh-Wooley and systolic array multipliers, barrel and logarithmic shifters, area-time tradeoff, power consumption issues; designing semiconductor memory and array structures: memory core and memory peripheral circuitry.

Module 4: Yield & reliability in VLSI circuit
Mechanism of yield loss in VLSI reliability requirement for VLSI, Mathematics of failure distribution reliability & failure rates, Failure mechanism; VLSI simulation using P-SPICE & Model-simulation software;

Suggested reading

A. VLSI technology- S. M Sze, McGraw Hill.
B. VLSI fabrication principles- S.K Gandhi, John Wiley & sons.
C. Physics & Technology of semiconductor devices- A.S.Grove, Wiley, New York
D. Microelectronics- J. Millman & Gurbial , Tata McGraw Hill.
E. Digital Integrated Circuits- A Design Perspective- J.M. Rabaey, A. Chandrakasan & B. Nikolic, PHI;
F. Basic VLSI Design- D.A. Pucknell and K. Eshraghian, PHI;
G. Introduction to VLSI Design- E.D. Fabricius,McGraw Hill,
H. Principles of CMOS VLSI Design- Weste and Eshraghian, Pearson Education;

Semester Three

Semester	Course Code	Course	L	T	P	C
3	EL 6111	Elective	3	3	0	6
	EL 6112	Project Phase 1	0	15	9	18
	Semester Total		**3**	**18**	**9**	**24**

Course Code	Course	L	T	P	C
EL 6111	Elective	3	3	0	6

EL 6111	**Elective**	A. Communication Networks
		B. Advanced Processor Architecture
		C. Embedded Systems
		D. Bio Medical Signal Processing
		E. Robotics
		F. Speech Processing
		G. Optical Sensors
		H. Information Theory
		I. Soft Computing
		J. Neural Networks
		K. Advanced Photonics
		L. Advanced Antenna Design
		M. Bio-Electronics
		N. Data Security
		O. Computer Vision
		P. Bluetooth
		Q. Bio-Informatics
		R. Optical Communication

Course Code	Course	L	T	P	C
EL 6111	Elective: A. Communication Networks	3	3	0	6

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, Chanellization;

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-archtecture, 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- Stalling, Pearson Education
4. Computer Networks- Tanenabaum, PHI

Course Code	Course	L	T	P	C
EL 6111	Elective: B. Advanced Processor Architecture	3	3	0	6

Unit 1: Introduction:
Evolution of processor design; Cost/ performance issues in high performance processor design, performance metrics;

Unit 2: Architectural abstractions- architecture, key features, the instruction set- principles and design; Arithmetic unit- arithmetic instructions and various implementations; Registers; Datapath and control unit- datapath requirements for different instruction classes; fixed-cycle vs. variable-cycle instruction implementation; Approach to control unit design - FSM control and microprogrammmed control; exceptions and exception handling; Performance enhancement techniques - pipelining and memory hierarchy: datapath pipelining; instruction-level pipelining; performance issues in pipelining; software pipelining. Space-time locality and cache memory; virtual memory, paging, TLB; case studies- 80286, 80386, 80486, 80586;

Unit 3: Instruction Set and introduction to programming 80x86
Edit, assembly, link, test, debug; use of code, data, and stack segments

Unit 4: I/O Interface
I/O performance measures; interfacing I/O to the memory, processor and OS; Interrupts and DMA; Data communication; Case studies (in brief): Intel x 86 families and the Pentium; RISC architectures like MIPS, SPARC, Power PC, PA-RISC.

Unit 5: Introduction to DSP Architectures
Key issues in DSP architecture design; pipelining and parallelism in instruction set; On-chip memories and I/O peripherals. Case study- ADSP 21xx/ 21xxx family and TMS 320C5x family DSPs; Software and hardware development tools;

Suggested reading

1. The 80x86 Family- Uffenbeck, Pearson Education
2. The Pentium Processor- Antanokos, Pearson Education
3. The Intel Microprocessor- Brey, Pearson Education
4. Microprocessors and Interfacing- Hall, TMGH
5. Advanced Microprocessors and Peripherals- Ray, Bhurchandi, TMGH
6. Digital Signal Processors- Kuo, Gan, Pearson Education

Course Code	Course	L	T	P	C
EL 6111	Elective: C. Embedded Systems	3	3	0	6

Unit 1: Introduction
Embedded system- definition, Types of processors used; Peculiarities and specialties; Requirement and Application

Unit 2: Processors and microcontrollers for embedded systems
Brief review of 8085, 8051, 8086, 80386, PIC processors and ARM based processor.

Unit 3: Operating systems for embedded systems: -
Need for an operating system; Different types like single user and tasking, multi user, multi tasking, time sharing, batch processing, real time; Micro kernel vs monolithic; Major functions-Process management, Memory management, File system Management, I/O management and Network management.; Concept of process, threads, task switching, scheduling, critical sections, deadlock.

Unit 4: Real time operating systems Issues
I/O programming- Synchronization, transfer rate and latency. Polled I/O issues. Interrupt driven I / O; ISR;. Response time- interrupt controller; Software interrupts and exceptions; Buffering of data and queuing of interrupt request; Concurrency control- Foreground / Background systems; Thread state and serialization, latency, prevention of interrupt overruns; Concurrent execution of threads, context switch, non-preemptive multitasking, preemptive multitasking; Critical sections:- disabling interrupts, disabling ask switch, spin lock, semaphore.

Unit 5: Scheduling in embedded systems
Conventional scheduling, deadline driven scheduling, rate monotonic scheduling, deadlock, watchdog timer; Memory management in embedded systems- Static allocation, dynamic allocation;. Recursion and dynamic allocation; shared memory, re-entrant functions; Boot up and System initialization. 80x86 microprocessor with a C compiler (suited for RTOS) and uC / OS RTOS; Real time Embedded System applications as case study;

Suggested readings

1. Fundamentals of Embedded Software- Daniel W Lewis, Pearson Education
2. An Embedded Software Primer- David E. Simon, Pearson Education
3. Embedded Systems Design- Ramani Kalpathi and Ganesh Raja,
4. Design with PIC microcontroller- Peatman,, Pearson Education
5. Microcontrollers- Rajkamal,, Pearson Education

Course Code	Course	L	T	P	C
EL 6111	Elective: D. Bio Medical Signal Processing	3	3	0	6

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; Electroglottograpic 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,
2. Biomedical Signal Processing- W. J. Tompkins, ed., Prentice Hall;
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

Course Code	Course	L	T	P	C
EL 6111	Elective: E. Robotics	3	3	0	6

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

1. Autonomous Robots- G. A. Bekey, MIT Press
2. Robotics and Control- Mittal, TMGH
3. Robotic Control- Fu, TMGH

Course Code	Course	L	T	P	C
EL 6111	Elective: F. Speech Processing	3	3	0	6

Unit1: 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;

Course Code	Course	L	T	P	C
EL 6111	Elective: G. Optical Sensors	3	3	0	6

Unit 1: Introduction
Light beam as a sensing tool, simple optical sensors, single and double optic levers, measurements of small displacements, radius of curvature-lamp and scale arrangement, angle of rotation, speed of rotation, stroboscope, method of triangulation, projected fringe technique, lidar for atmospheric remote sensing, lidar equation

Unit 2 - Interferometry for precision measurements
Two-beam interferometry, Michelson interferometer, fringe displacement and fringe counting, heterodyne interferometer, super heterodyne interferometry, electron speckle pattern interferometry photoelastic measurements, Moiré technique

Unit 3 - Optical fiber sensors-
General features, types of OFS, intrinsic and extrinsic sensors, intensity sensors, shutter based multimode OFS, simple fibre based sensors for displacement, temperature and pressure measurements- reflective FOS and applications, Fibre Bragg grating based sensors

Unit 4 - Light transmission in micro bend fibers
Basic principles, micro bend OFS, measurements with micro bend sensors, evanescent wave phenomenon, evanescent wave FOS, chemical sensors using EWFOS, distributed sensing with FOS, OTDR and applications, FO smart sensing

Unit 5- Interferometric FOS-
Basic principles, interferometric configurations, Mach-Zender, Michelson and Fabri-Perot configurations- components and construction of interferometric FOS, applications of interferometric FOS, Sagnac interferometer, fiber gyro, OTDR and applications

Suggested Reading

1. Fundamentals of Fiber Optics in Telecommunications and Sensor Systems - B.P. Pal
2. Optics - Ajoy Ghatak
3. Lasers, Theory and Applications - Thyagarajan & Ghatak.
4. Optical Measurement Techniques and Applications - P K Rastogi

Course Code	Course	L	T	P	C
EL 6111	Elective:H. Information Theory	3	3	0	6

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

1. Information Theory and coding- N.Abrahamson, McGraw Hill Book Co., 1963.
2. Information theory and reliable communication- R.G.Gallagar, Wiley New York, 1968.
3. Principles of Practices of Information Theory-Richard.E.Balhut, Addison Wesley Pub.Co.,1987.

Course Code	Course	L	T	P	C
EL 6111	Elective: I. Soft Computing	3	3	0	6

Unit 1: Artificial Neural Networks
Basic-concepts-single layer perception-Multi layer perception-Supervised and un supervised 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

1. Neuro Fuzzy and Soft computing- Jang J.S.R., Sun C.T and Mizutami E, Prentice Hall;
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 ;
5. Artificial Intelligence- Nih.J.Ndssen Harcourt Asia Ltd.,Singapore;

Course Code	Course	L	T	P	C
EL 6111	Elective: J. Neural Networks	3	3	0	6

Course Objective

The course provides the foundation of Artificial Neural network. It provides the basic principles and ANN and provides the exposure to Pattern Recognition and machine Learning.

Module 1: Introduction

Machine Perception, Pattern Classification Systems, Design Cycle, Learning and Adaptation; Bayesian Decision theory-Continuous & Discrete features, Minimum Error-Rate, Classification, Classifiers;

Module 2: Parameter Estimation

Maximum Likelihood Estimation, Bayesian Estimation, Hidden Markov Model;
Nonparametric Methods- Density Estimation, Parzen Windows, k-Nearest Neighbour Estimation; Introduction to fuzzy set & fuzzy classification; Linear Discriminant Functions;

Module 3: Neural Networks

Introduction, Biological Neurons, Artificial Neurons – various models, transfer functions; Learning methods, Stability and Convergence, Functional units for Pattern Recognition tasks; Single Layered Perceptron- LMS algorithm, Relation between perceptron and Bayes Classifier for a Gaussian Environment;

Module 4: Multilayered Perceptrons

Feed Forward and Feed Backward Networks, Back Propagation Algorithm, Feature Detection, Network pruning, Supervised learning as an Optimization problem, Convolution Networks, Radial Basis Function Networks; Introduction to SVM-application for a Pattern Recognition Task & Non Linear Regression;

Module 5: Self-Organizing Maps

Principles of Self-Organization, PCA, Two basic feature-Mapping Models, SOM Algorithm, Learning Vector Quantization; Introduction to neuro-hardware;

Module 6: Case study

Application of neural networks for data compression, character recognition, speech recognition etc;

Suggested reading

1. Pattern Classification- R. O. Duda, P. E. Hart and D. G. Stork, John Wiley;
2. Neural Networks- S. Haykin, 2nd Edition, Pearson Education;
3. Artificial Neural Networks- B. Yegnanarayana, PHI;
4. Neural Networks using Matlab 6.0- S. N. Sivanandam, S. Sumathi, S. N. Deepa, TMGH;
5. Computer Vision- D. A. Forsyth & J. Ponce, Pearson Education;

Course Code	Course	L	T	P	C
EL 6111	Elective: K. Advanced Photonics	3	3	0	6

Unit 1: Atom Optics
Linear atom optics-light forces on atoms, atomic cooling, Doppler and Sisyphus cooling, evaporative cooling, atomic beam collimation and focusing, channeling by standing waves, evanescent field mirrors, focused laser beam mirrors; Atomic diffraction- Ramn-Nath and Bragg regime, grating and interferometers, atomic traps and cavities, magneto optic, magnetic and optical traps, atomic waveguides; Quantum atom optics- Matter wave coherence, Bose-Einstein condensation, experiments in alkali vapors, atom lasers, matter wave solitons; Nonlinear wave mixing-Atomic four wave mixing, mixing of optical and matter waves, parametric amplification of atomic and optical fields; Entanglement between atomic and optical fields, matter waves super radiance, matter wave amplification, application of atom optics

Unit 2: Industrial Photonics
Photonics Technology- components, couplers, isolators, circulators, multiplexers and filters, fibre gratings, interferometers, FO amplifiers, transmitters and detectors, switches, wavelength converters, nonlinear effects in signal transmission, self phase and cross phase modulation, soliton pulse propagation; Test beds, LAMBDANET, STARNET, rainbow, wavelength routing network, optical layer in network, node design, Networking design and operation, routing wavelength assignment; Wavelength routing test beds: AON, NTTR, ONTC, MONET;

Unit 3: Bio Photonics
Photobiology- interaction of light with cells and tissues, photo-processes in Biopolymers, human eye and vision, photosynthesis; Photo-excitation-free space propagation, optical fiber delivery system, articulated arm delivery, hollow tube wave- guides; Optical coherence tomography, spectral and time-resolved imaging, fluorescence resonance energy transfer imaging, nonlinear optical imaging; Bio-imaging- transmission microscopy, Kohler illumination, microscopy based on phase contrast, dark-field and differential interference contract microscopy, fluorescence, confocal and multi-photon microscopy; Applications of bio-imaging: Bio- imaging probes and fluorophores, imaging of microbes, cellular imaging and tissue imaging;
Optical biosensors-fluorescence and energy transfer sensing, molecular beacons and optical geometries of bio-sensing, biosensors based on fiber optics, planar waveguides, evanescent waves, interferometric and surface plasmon resonance; Flow cytometry: basics, fluorochromes for flow cytometry, DNA analysis;
Laser activated therapy- photodynamic therapy, photo-sensitizers for photodynamic therapy, applications of photodynamic therapy, two photon photodynamic therapy; Tissue engineering using light: contouring and restructuring of tissues using laser, laser tissue regeneration, femto-second laser surgery; Laser tweezers and laser scissors, design of laser tweezers and laser scissors, optical trapping using non Gaussian optical beam, manipulation of single DNA molecules, molecular motors, lasers for genomics and proteomics, semiconductor quantum dots for bio imaging, metallic nano-particles and nano-rods for bio-sensing;
Photonics and biomaterials: bacteria as bio-synthesizers for photonic polymers;

Unit 4: Optical Processing
Fresnel transform, Effect of lens on wavefront, FT property of lens, OTF, time and space integrating architecture, spectrum analysis, Vanderlugt filter; SLMs AO, MO, EO and LC based SLMs, optical numerical processing, simple arithmetic, evaluation of polynomials, optical implementation of matrix vector multiplication, differentiation, integration, partial differential equations;

Optical neural network- characterization of ANN, supervised and unsupervised learning, neuron as nonlinear element, associative memory and vector matrix multiplication, double and multilayer NN, Hopfield net, optical implementation of neural networks;

Suggested reading:

1. Optical Networks: A Practical applications - R Ramaswami and K N Sivarajan
2. Photonic Switching Technology - H T Mouftah, J M H Elmirghani
3. Deploying Optical Networking Components - Gil Held
4. Optical Interconnection - C Tocci, H J Caulfield
5. Introduction to Bio-Photonics - V N Prasad
6. Biomedical Photonics: A Handbook - T Vo Dinh
7. Atom Optics - P Meystre
8. Laser Cooling and Atom Traps - Metcalfe
9. Fundamentals of Fibre Optics in Telecommunications and Sensor Systems - B.P. Pal
10. Optics - Ajoy Ghatak
11. Lasers, Theory and Applications - Thyagarajan & Ghatak.
12. Optical Measurement Techniques and Applications - P K Rastogi
13. Signal Processing using Optics - B G Boone
14. Optical Computing - D G Feitelson

Course Code	Course	L	T	P	C
EL 6111	Elective: L. Advanced Antenna Design	3	3	0	6

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-Babinets 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 refuse, 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
5. Third-Generation Systems and Intelligent Wireless Networking: Smart Antennas and Adaptive Modulation- Blogh & Hanzo, Willey-IEEE Press;

Course Code	Course	L	T	P	C
EL 6111	Elective: M. Bio-Electronics	3	3	0	6

Course Objective:
The course provides the basic understanding of Bio-Electronics, its importance, principles, devices, device modeling and application.

Module 1: Introduction
Nature of Biomedical signals; Bio Electronic potentials; Necessity of Bio Electronics; Components; Scope and Application; Basics of cell biology; Structure of the cell, the nervous system and the neuron; function of enzymes; nucleus and role of DNA and RNA, adhesion of cell to surfaces.

Module 2: Electrical Circuit treatment of biological environments
Behaviour of cells on semiconductor materials; Ionic conduction, the metal-electrolyte double layer, models of the cell membrane; Cell culture and biocompatibility testing; Mathematical modeling of the nervous system. Use of model neurons for associative computer memory; Bio-inspired systems;

Module 3: Electrical signal detection in biological systems
Silicon, glass and metal electrodes, amplifier design; Fundamentals of electron transfer and its application in bio electronic systems;.

Module 4: Bioelectronic device production
Microelectronic fabrication methods as adapted to Bioelectronics, hard and soft lithography, bio-compatibility of materials.

Module 5: Biosensors:
Importance, working, types; Miniaturization and Microsystems including sensing using optical techniques, field effect transistors, ion-selective and enzymatic sensitive electrodes, as well as impedance monitoring.

Module 6: Case study
Examples of industrial biosensors, e.g. for glucose monitoring and for DNA
Analysis and some others;

Suggested reading

1. Biosensors- E A Hall, Wiley;
2. Electrodes and Membranes- J Koryta Ions, Wiley ;
3. Bioelectronics- S Bone & B Zabba, Wiley;

Course Code	Course	L	T	P	C
EL 6111	Elective: N. Data Security	3	3	0	6

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

Course Code	Course	L	T	P	C
EL 6111	Elective:O. Computer Vision	3	3	0	6

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
4. Computer Vision- D. H. Ballard and C. M. Brown, Prentice Hall;
5. Pattern Classification and Scene Analysis- P. E. Hart and R. O. Duda, John Wiley;
6. Machine Vision- R. Jain, R. Kasturi and B. G. Schunck, McGraw-Hill;
7. Vision- D. Marr, Freeman and Co;
8. Digital Image Processing R. C. Gonzalez and R. E. Woods, Pearson Education
9. Pattern Recognition – Statistical, Structural and Neural Approaches- R. Schalkoff, John Wiley;

Course Code	Course	L	T	P	C
EL 6111	Elective:P. Bluetooth	3	3	0	6

Course Objective:
The course provides the basic understanding of Bluetooth, architecture, protocols and application.

Module 1: Introduction
Overview and Objectives of Bluetooth technology, Piconets and Scatternets; Bluetooth version 1.0b, Bluetooth version 1.1; Applications; Advantage and disadvantage;

Module 2: Bluetooth Architecture and Protocol
Bluetooth profiles- Serial Port, Headset, Intercom, Fax; Bluetooth APIs; Protocol layers; Bluetooth Radio layer, Base band layer, Bluetooth addressing, Link Management Protocol, L2CAP, Host Controller Interface (HCI) , RFCOMM;

Module 3: Working with Bluetooth Devices
Configuring a Bluetooth-enabled mobile phone; Pairing with a headset; Pairing with other devices; Enabling and verifying Bluetooth security; Installing Bluetooth hardware; Installing Bluetooth driver software; Verifying interfaces and drivers; Bluetooth Configuration Tool; Testing the hardware; Configuring Bluetooth COM ports; Device discovery; Device properties; Service discovery;

Module 4: Bluetooth Security and Services
Bluetooth Security- Basics, Configuring Trust; Configuring Security Modes; Configuring Bonding;

Module 5: Bluetooth Services
Bluetooth services- Providing wireless access to a LAN, Creating a Bluetooth dial-up access point, Creating a Bluetooth Internet access point, Creating a Bluetooth Fax gateway, Security considerations; Accessing Internet services via a Bluetooth-enabled mobile phone; Accessing a corporate network via a Bluetooth-enabled mobile phone; Sending FAXes via Bluetooth; Troubleshooting resource access; Bluetooth products- Mobile phones, Pocket PCs and PDAs, Bluetooth adapters, PC adaptors: USB, PCMCIA, Bluetooth Access Points, Differentiating factors;

Suggested Reading

1. Data Communications and Networking- Forouzan, TMGH
2. Wireless Communications and Networks- Stallings, Pearson Education
3. Data Communications- Stalling, Pearson Education
4. Computer Networks- Tanenabaum, PHI

Course Code	Course	L	T	P	C
EL 6111	Elective:Q. Bio-Informatics	3	3	0	6

Unit 1: Introduction
Evolution, Necessity, Basic Biology, Basic Mathematics, Biological Chemistry, Statistical Techniques; Introduction to Genome;

Unit 2: Genetic Information Flow & Processing
Introduction, Information content in DNA, RNA, gene; Biodiversity Informatics; Structural Biology; Cell Biology, Basic Protein Geometry and Least-Squares Fitting; Large-scale Censuses and Genome Comparisons; Genetics & Immunology; Chemoinformatics;

Unit 3: Biological Databanks
Basic principles; Protein Domains and Modules; Taxonomy & Phylogeny; Comparative Genomics and Proteomics; Parasite Bioinformatics; Metabolomes and Metabolic Pathway Engineering; Genome to Drug and Vaccine

Unit 4: Computational Processing
Concepts in Computing & Computer Programming; Introduction to Database Systems; Computer Graphics and Visualization; Programming in Object Oriented Languages Molecular Dynamics & Monte Carlo; Machine Learning Techniques; Distributed Computing; Object Oriented and Relational Databases; Data Mining and Data Security;

Unit 5: Applications of Bioinformatics
Applications in Agriculture, Human Health, Environment, Biotechnology, Molecular Biology, Neurobiology, Drug Designing, Veterinary Sciences; Emerging Areas

Suggested Reading

1. Sequence Analysis Primer- Gribskov & Deveraux
2. Database System Concepts- Korth & Silberschatz
3. Dynamics of Proteins & Nucleic Acids- McCammon & Harvey.

Course Code	Course	L	T	P	C
EL 6111	Elective: R. Optical Communication	3	3	0	6

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

Course Code	Course	L	T	P	C
EL 6112	Project Phase 1	0	15	9	18

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.

Semester Four

Semester	Course Code	Course	L	T	P	C
4	EL 6121	Project Phase II	0	18	18	24
	Semester Total		**0**	**18**	**18**	**24**

Course Code	Course	L	T	P	C
EL 6121	Project Phase II	0	18	18	24

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 an 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 secions, 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%