**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

Course Book for

M. Tech. in Communication System Engineering

For

**Academic Year**
**2019 - 2020**

# Visvesvaraya National Institute of Technology,

# Nagpur-440 010 (M.S.)

## Institute Vision Statement

To contribute effectively to the National and International endeavour of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country and the World incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation.

## Institute Mission Statement

The mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. VNIT is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

## Department Vision Statement

The Department endeavors to facilitate state of the art technical education in the field of Electronics and Communication Engineering by infusing scientific temper in the students leading towards research and to grow as centre of excellence in the field. The vision of the department is to provide education to students that is directly applicable to problems and situations encountered in real life and thus foster a successful career. The department aims to provide the best platform to students and staff for their growth

## Department Mission Statement

1. To be the epitome of academic rigour, flexible to accommodate every student and faculty for basic, current and future technologies in Electronics and Communication Engineering.
2. Strengthening and providing support in sustaining a healthy society by improving the quality of life through the application of technology.

## Brief about Electronics and Communication Department:

The Department of Electronics and Computer Science was created in 1994 from the Department of Electrical Engineering. Later, the Department of Electronics and Communication Engineering has been created in May 2014. It offers under-graduate program (B.Tech.) in Electronics and Communication Engineering and post-graduate program (M.Tech.) in Communication Systems Engineering. The department has well qualified and well motivated faculty members and support staff. There are more than 30 full time PhD students enrolled in the department in the areas of Communication Engineering, Image Processing, Embedded System Design, RF and Antenna

Design. The laboratories are adequately equipped with state-of-the-art facilities. The department is undergoing vigorous growth in emerging areas of Embedded Systems, RF Testing and Communications. Currently, the department has been awarded Center of Excellence in Combedded Systems by MHRD (NPIU). The department is actively involved in R & D as well as consultancy projects and has collaborations with several industries, academic institutes, and R&D organizations in the country. The B.Tech. (ECE) program offered by the Department is accredited by National Board of Accreditation (NBA) for five years w.e.f. July 1, 2015.

**List of faculty Members**

| Sr No | Faculty Name | Areas of specialization |
|---|---|---|
| 1. | Dr. A. G. Keskar | Fuzzy Logic, Image Processing, Embedded Systems. |
| 2 | Dr. A. S. Gandhi | Wireless communication, RF circuits and systems, Computer networks |
| 3 | Dr. K. M. Bhurchandi | Embedded Systems, Image Processing |
| 4 | Dr. K. D. Kulat | Wireless Communication, Devices and Circuits |
| 5 | Dr. Ashwin Kothari | Communication, Signal processing, Rough Sets, Cognitive Radio, Reconfigurable Antennas, COMMBEDDED Systems: Hybridization of Communication and Embedded Systems. |
| 6 | Dr. V. R. Satpute | Image Processing, Computer Vision, Signal Processing, Cryptography, Bio-metrics. |
| 7 | Dr. Prabhat Sharma | Wireless and Molecular Communications, Evolutionary algorithms, Signal Processing and Machine Learning for communications. |
| 8 | Dr. Saugata Sinha | Image Processing, Pattern Recognition, Medical Imaging. Signal Processing. |
| 9 | Dr. Deep Gupta | Medical Imaging, Signal & Image Processing, Ultrasound , Medical Image Processing and Analysis, Multimedia application |
| 10. | Dr. (Mrs.) P. H. Ghare | Body Area Networks, Wireless Sensors Network, Analog Circuit Design |
| 11 | Dr. J. Sengputa | Communication & Microwave |
| 12 | Dr. Neeraj Rao | Antennas and Microwave |
| 13 | Dr. Ankit Bhurane | Signal Processing, Video and Image Processing, Machine Learning |

| | | |
|---|---|---|
| 14 | Dr. K. Surender | Control and Instrumentation |
| 15 | Dr. Punitkumar Bhavsar | Cyber-Physical Systems, Control Engineering |
| 16 | Dr. Anamika Singh | Photonic Integrated Circuits, Optoelectronics |
| 17 | Ms. Snigdha Bhagat | Image Processing, Computer Vision, Machine Learning |

## PG Programme Offered by Electronics and Communication Department:

The department offers following postgraduate programme

| | Program | Description |
|---|---|---|
| **PG** | M. Tech. in Communication System Engineering | Intake: 25 |

**Credit System at VNIT :**

Education at the Institute is organized around the semester-based credit system of study. The prominent features of the credit system are a process of continuous evaluation of a student's performance / progress and flexibility to allow a student to progress at an optimum pace suited to his/her ability or convenience, subject to fulfilling minimum requirements for continuation. A student's performance/progress is measured by the number of credits he/she has earned, i.e. completed satisfactorily. Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum number of credits and a minimum grade point average must be acquired by a student in order to qualify for the degree.

**Course credits assignment**

Each course, except a few special courses, has certain number of credits assigned to it depending on lecture, tutorial and laboratory contact hours in a week.
For Lectures and Tutorials: One lecture hour per week per semester is assigned one credit and
For Practical/ Laboratory/ Studio: One hour per week per semester is assigned half credit.
Example: Course XXXXXX with (3-0-2) as (L-T-P) structure, i.e. 3 hr Lectures + 0 hr Tutorial + 2 hr Practical per week, will have (3x1 + 0x1 + 2x0.5 =) 4 credits.

**Grading System**

The grading reflects a student's own proficiency in the course. While relative standing of the student is clearly indicated by his/her grades, the process of awarding grades is based on fitting performance of the class to some statistical distribution. The course coordinator and associated faculty members for a course formulate appropriate procedure to award grades. These grades are reflective of the student's performance vis-à-vis instructor's expectation. If a student is declared pass in a subject, then he/she gets the credits associated with that subject.

Depending on marks scored in a subject, a student is given a Grade. Each grade has got certain grade points as follows:

| Grade | Grade points | Description |
|---|---|---|
| AA | 10 | Outstanding |
| AB | 9 | Excellent |
| BB | 8 | Very good |
| BC | 7 | Good |
| CC | 6 | Average |
| CD | 5 | Below average |
| DD | 4 | Marginal (Pass Grade) |
| FF | 0 | Poor (Fail) /Unsatisfactory / Absence from end-sem exam |
| NP | - | Audit pass |
| NF | - | Audit fail |
| SS | - | Satisfactory performance in zero credit core course |
| ZZ | - | Unsatisfactory performance in zero credit core course |
| W | - | Insufficient attendance |

**Performance Evaluation**

The performance of a student is evaluated in terms of two indices, viz, the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. CGPA is rounded up to second decimal.

The Earned Credits (ECR) are defined as the sum of course credits for courses in which students have been awarded grades between AA to DD. Grades obtained in the audit courses are not counted for computation of grade point average.

Earned Grade Points in a semester (EGP) = **Σ** (Course credits x Grade point) for courses in which AA- DD grade has been obtained.

SGPA = EGP / Σ (Course credits) for courses registered in a semester in which AA- FF grades are awarded.

CGPA= EGP / Σ(Course credits) for courses passed in all completed semesters in which AA- DD grades are awarded.

**Overall Credits Requirement for Award of Degree**

| SN | Category of Course | Symbol | Credit Requirement | | | |
|---|---|---|---|---|---|---|
| | | | B. Tech. (4-Year) | B. Arch. ( 5 Year) | M. Tech. (2 Year) | M. Sc. (2 Year) |
| | **Program Core** | | | | | |
| 1 | Basic Sciences (BS) | BS | 18 | 04 | - | - |
| 2 | Engineering Arts & Sciences (ES) | ES | 20 | 18 | - | - |
| 3 | Humanities | HU/ HM* | 05 | 06 | - | - |
| 4 | Departmental core | DC | 79-82 | 168 | 33-39 | 54-57 |
| | **Program Elective** | | | | | |
| 3 | Departmental Elective | DE | 33-48 | 17-23 | 13-19 | 06-09 |
| 4 | Humanities & Management | HM | 0-6 | 0-3 | - | - |
| 5 | Open Course | OC | 0-6 | 0-3 | - | - |
| **Total requirement :BS + ES + DC+ DE + HM + OC =** | | | **170** | **219** | **52** | **63** |
| **Minimum Cumulative Grade Point Average required for the award of degree** | | | **4.00** | **4.00** | **6.00** | **4.00** |

**Attendance Rules**

1. All students must attend every class and 100% attendance is expected from the students. However, in consideration of the constraints/ unavoidable circumstances, the attendance can be relaxed by course coordinator only to the extent of not more than 25%. Every student must attend minimum of 75% of the classes actually held for that course.
2. A student with less than 75% attendance in a course during the semester will be awarded W grade. Such a student will not be eligible to appear for the end semester and re-examination of that course. Even if such a student happens to appear for these examinations, then, answer books of such students will not be evaluated.
3. A student with W grade is not eligible to appear for end semester examination, reexamination & summer term.

**Program Outcomes (Department Specific) for M.Tech in Communication System Engineering**

**PO1:** An ability to independently carry out research/investigation and development work to solve practical problems

**PO2:** An ability to write and present a substantial technicalreport/document

**PO3:** Students should be able to demonstrate adegree of mastery over the area as per thespecializat ion of the program. The mastery shouldbe at a level higher than the requirements in theappro priate bachelor program

**PO4:** To achieve competence in designing, analyzing and testing electronic systems for social, industrial and research applications in communication, signal processing and embedded systems.

**PO5:** To inculcate research attributes and approach through industry oriented internships and projects.

**Curriculum of the courses of study**

## Courses to Register in First Year M. Tech.

### I Semester

| Sr. No. | Code | Course Title / Name | Type | L-T-P | Credits | Page No. |
|---|---|---|---|---|---|---|
| ***Core Courses*** | | | | | | |
| 1 | ECL525 | Signal Processing For Communication System | DC | 3-0-0 | 3 | 10 |
| 2 | ECL524 | Statistical Signal Analysis | DC | 3-0-0 | 3 | 12 |
| 3 | ECL521 | Information Theory And Coding | DC | 3-0-0 | 3 | 14 |
| 4 | ECL523 | Wireless Channels | DC | 3-0-0 | 3 | 16 |
| 5 | ECL 520 | Computational Electromagnetism | DC | 3-0-0 | 3 | 18 |
| 6 | ECP518 | Communication System -I | DC | 0-0-2 | 1 | 20 |
| 7 | ECP525 | Signal Processing For Communication System | DC | 0-0-2 | 1 | 21 |
| ***Elective Courses Theory: Maximum one Lab: Maximum two)*** | | | | | | |
| 8 | ECL424 | Optical Communication | DE | 3-0-0 | 3 | 29 |
| 9 | ECP424 | Optical Communication | DE | 0-0-2 | 1 | 31 |
| 10 | ECL402 | Communication Networks & Network Applications | DE | 3-0-0 | 3 | 32 |
| 11 | ECP402 | Communication Networks & Network Application Lab | DE | 0-0-2 | 1 | 34 |
| 12 | ECL416 | Fuzzy Logic And Neural Networks | DE | 3-0-0 | 3 | 35 |
| 13 | ECL418 | Network Planning And Management | DE | 3-0-0 | 3 | 36 |
| 14 | ECL513 | Synchronization And Tracking | DE | 3-0-0 | 3 | 37 |
| 15 | ECL428 | Industrial Communication Systems | DE | 3-0-0 | 3 | 38 |
| 16 | ECP440 | Cyber Law And Telecom Regulation Workshop | DE | 0-0-2 | 1 | 39 |
| 17 | ECP441 | Network Standards Workshop | DE | 0-0-2 | 1 | 40 |
| 18 | ECP442 | Software Engineering Workshop | DE | 0-0-2 | 1 | 41 |
| 19 | ECL526 | Computer Vision | DE | 3-0-0 | 3 | 42 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 20 | ECP526 | Computer Vision | DE | 0-0-2 | 1 | 44 |
| | | Total Credits (DC + DE) | | | 18 | |

**II Semester**

| Sr. No. | Code | Course Title / Name | Type | L-T-P | Credits | Page No. |
|---|---|---|---|---|---|---|
| ***Core Courses*** | | | | | | |
| 1 | ECL533 | Communication Theory | DC | 3-0-0 | 3 | 22 |
| 2 | ECL516 | Converged Communication Networks | DC | 3-0-0 | 3 | 24 |
| 3 | ECL409 | Radio Frequency Circuit Design | DC | 3-0-0 | 3 | 25 |
| 4 | ECP519 | Communication System Lab-II | DC | 0-0-2 | 1 | 26 |
| ***Elective Courses Theory: Maximum three Lab: Maximum one)*** | | | | | | |
| 5 | ECP409 | Radio Frequency Circuit Design | DE | 0-0-2 | 1 | 45 |
| 6 | ECL406 | Mobile Communication Systems | DE | 3-0-0 | 3 | 47 |
| 7 | ECL410 | Satellite Communication | DE | 3-0-0 | 3 | 49 |
| 8 | ECL411 | Digital Image Processing | DE | 3-0-0 | 3 | 51 |
| 9 | ECL413 | Adaptive Signal Processing | DE | 3-0-0 | 3 | 52 |
| 10 | ECL419 | Wireless Sensor Networks | DE | 3-0-0 | 3 | 53 |
| 11 | ECL420 | Smart Antennas | DE | 3-0-0 | 3 | 55 |
| 12 | ECL427 | Broadband Communication | DE | 3-0-0 | 3 | 57 |
| 13 | ECL511 | Non-Linear System Modelling | DE | 3-0-0 | 3 | 59 |
| 14 | ECL515 | Intelligent System Design | DE | 3-0-0 | 3 | 60 |
| 15 | ECL527 | Spectrum Management | DE | 3-0-0 | 3 | 62 |
| 16 | CSL528 | Cryptography And Information Security | DE | 3-0-0 | 3 | 65 |
| 17 | ECL529 | Advanced Computer Architecture | DE | 3-0-0 | 3 | 66 |
| | | Total Credits (DC + DE) | | | 15 | |

## Courses to Register in Second Year M. Tech.

**III Semester**

| Sr. No. | Code | Course Title / Name | Type | L-T-P | Credits | Page No. |
|---|---|---|---|---|---|---|
| | | ***Core Courses*** | | | | |
| 1 | ECD501 | Project Phase - I | DC | 0-0-0 | 3 | 27 |
| | | ***Elective Courses (Any Four)*** | | | | |
| 2 | ECL425 | High Power RF Devices And Systems | DE | 3-0-0 | 3 | 68 |
| 3 | ECL514 | Electromagnetic Interference And Compatibility | DE | 3-0-0 | 3 | 70 |
| 4 | ECL530 | Contemporary Embedded Systems | DE | 3-0-0 | 3 | 72 |
| 5 | ECL531 | Machine Learning And Learning Machines | DE | 3-0-0 | 3 | 73 |
| 6 | ECL532 | Wavelets And Multi-Media Applications | DE | 3-0-0 | 3 | 75 |
| 7 | ECL512 | Topics In Communication Systems | DE | 3-0-0 | 3 | 76 |
| 8 | MAL503 | Optimization Techniques | DE | 3-0-0 | 3 | 78 |
| 9 | MAL504 | Linear Algebra And Applications | DE | 3-0-0 | 3 | 79 |
| 10 | CSL517 | Pattern Recognition | DE | 3-0-0 | 3 | 81 |
| 11 | ECL 528 | Detection and Estimation in Wireless Systems | DE | 3-0-0 | 3 | 83 |
| | | Total Credits (DC + DE) | | | 15 | |

**IV Semester**

| Sr. No. | Code | Course Title / Name | Type | L-T-P | Credits | Page No. |
|---|---|---|---|---|---|---|
| | | ***Core Courses*** | | | | |
| 1 | ECD502 | Project Phase-II | DC | 0-0-0 | 9 | |

**L-T-P = 3-1-0 Means, Three Theory Hrs + One Tutorial hrs + Zero Labs or Practical Hrs per Week. L-T-P = 0-0-2 Means, Two Hrs of Lab or Practical per Week**

**DETAILED COURSE CONTENTS**

**CORE COURSES**

**ECL525 Signal Processing for Communication Systems [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course outcomes**

Students will

1. review basics of digital signal processing and to study the advances in digital signal processing mechanism.
2. study different transform techniques like STFT, DCT, DWT.
3. study application of different transform techniques
4. study various methods and algorithms for adaptive signal processing.
5. study the role of adaptive signal processing in the field of communication engineerin

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 2 | 1 |
| **CO2** | 3 | 1 | 3 | 1 | 1 |
| **CO3** | 3 | 1 | 3 | 1 | 2 |
| **CO4** | 3 | 1 | 1 | 1 | 2 |
| **CO5** | 3 | 1 | 1 | 2 | 2 |

**Contents**

Short Term Fourier Transform (STFT) and spectrum analysis for speech processing, Discrete Cosine Transform (DCT) and its application to image compression. Discrete Wavelet Transform (DWT), Applications of DWT.

Application of STFT for Speech processing. Application of DCT in Image compression. Applications of DWT.

Spectral factorization theorem and innovation processes, autoregressive moving average processes; Linear minimum mean-square error (LMMSE) estimation: minimum mean-square error(MMSE) estimation of jointly Gaussian random variable.

FIR Wiener filters, linear prediction-forward and backward predictions, IIR Wiener filters; Kalman filters, Adaptive filters, steepest descent solution of FIR Wiener filter, LMS algorithm-convergence, steady-state behaviour and practical considerations, RLS algorithm- method of least-squares, recursive solution and square-root algorithms, application of adaptive filters-equalization and noise cancellation.

Computational characteristics of DSP algorithms and applications; Techniques for enhancing computational throughput: Harvard architecture, parallelism, pipelining, dedicated multiplier, split ALU and barrel shifter

**Text Books**


1. S. Haykin Adaptive Filter Theory4th edition Prentice Hall
2. Khalid Sayood Introduction to Data Compression 2ndeditionMorgan Kaufmann Publishers
3. R. M. Rao and A. S. Bopardikar Wavelet Transforms: Introduction to theory and Application 4th edition Pearson Edition


**Reference Books**


1. S. K. Mitra *Digital Signal Processing: A Computer Based Approach* 4th EDITION TMH

**ECL524 Statistical Signal Analysis [(3-0-0); Credit: 3]**

**Course Outcomes**

Students will

1. understand the significance and importance of Probability and Statistics in Real life, Engineering and Industrial applications.
2. consolidate the theoretical foundations of Probability and Statistics theory.
3. use theory for probability estimation, decision making and statistical inference.
4. apply the theory to real life, engineering and industrial problems.
5. formulate Probabilistic and Statistical models of real life/ engineering problems and use them.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | | 3 | 2 | 1 |
| **CO2** | 2 | | 2 | 3 | |
| **CO3** | 2 | | 2 | 2 | |
| **CO4** | 3 | 1 | 3 | 2 | 2 |
| **CO5** | | 2 | 3 | 2 | |

**Contents**

Review of probability theory, Bayes theorem, total probability theoem,.

Random variables, PDF, CDF, moments, standard random variables, moment generating function, characteristic function, joint distributions, function of one random variable, function of two random variables, correlation of random variables, Complex random variables.

laws of large numbers, central limit theorem, convergence of sequence of random variables. Introduction to random processes, specification of random processes, Stationary and ergodic processes, nth order joint PDFs, independent increments, stationary increments, Markov property, Markov process and martingales, Gaussian process, Poisson process and Brownian motion.

Response of Processes to LTI Systems Mean and correlation of random processes, stationary, wide sense stationary and ergodic processes. Random processes as inputs to linear time invariant systems: power spectral density, Gaussian processes as inputs to LTI systems, white Gaussian noise. In-Phase and quadrature representation of random processes.

**Text Books**


1. Papoulis and S. U. Pillai, “Probability, Random Variables and Stochastic Processes”, 4th Edition, McGraw Hill 2002
2. Stark and John W. Woods, “Probability and Random Processes with Applications to Signal Processing”, Prentice Hall, 3 rd Edition 2001

3. Cooper, George R., and Clare D. McGillem. *Probabilistic methods of signal and system analysis*. No. BOOK. Oxford University Press, 1986.

**Reference Books**

1. Geoffrey Grimmett, "Probability and Random Processes", 3rd edition, Oxford University Press 2001
2. Yannis Viniotis, "Probability and Random Processes for Electrical Engineers" McGraw-Hill College,1998
3. Albert Leon Garcia: "Probability and Random Processes for Electrical Engineering", Prentice Hall 1993 .
4. V. Krishnan: "Probability and Random Processes", John Wiley & Sons 2006

**ECL521 Information Theory and Coding [(3-0-0); Credit: 3]**

**Course Outcomes**

Students will

1. Analyze self and mutual information.
2. Evaluate the information rate of various information sources.
3. Design lossless data compression codes for discrete memory-less sources.
4. Evaluate the information capacity of discrete memory-less channels and determine possible code rates achievable on such channels.
5. Design simple linear block error correcting codes, select and design simple convolutional codes.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 2 | 2 |
| **CO2** | 3 | 1 | 3 | 2 | 2 |
| **CO3** | 3 | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 1 | 3 | 3 | 2 |
| **CO5** | 3 | 1 | 3 | 3 | 2 |

**Contents**

Communication processes, Channel matrix, Probability relation in a channel, the measure of information, Entropy function – Properties of entropy function,n Mutual Information, Symmetry of information, Jensen's Inequality, Fano's Inequality.

Channel capacity; Special types of channels and their capacity, Noiseless channels symmetric channel, erasure channels, continuous channels, Shannon's theorem, Shannon Hartley theorem for AWGN channels.

Encoding: Block code, Binary code, Binary Huffman code, Shannon–Fano Encoding procedure, Noiseless coding theorem. Error – correcting codes. Examples of codes, Hadamard matrices and codes, Binary Colay code, Matrix description of linear codes, Equivalence of linear codes, The Hamming codes, The standard array, Syndrome decoding.

Introduction to Rate Distortion Theory, MIMO Information Theory: Concept of diversity, introduction to MIMO systems, space-time coding, MIMO Channels, capacity of MIMO channels, ergodic capacity.

**Text Books**

1. T.M.Cover and J.A Thomas, "Elements of information theory", John Wiley and Sons.
2. S .Haykins, " Communication Systems" John Wiley and Sons.

3. R Bose, “Information Theory, Coding and Cryptography”, 2E, Tata-McGraw Hill, New Delhi.

**Reference Books**

1. G. A. Jones et. Al, “Information and Coding Theory”, Springer – Verlag.
2. J. H. Van Lint, “ Introduction to Coding Theory”, Springer –Verlag.

**ECL523 Wireless Channels [(3-0-0); Credit: 3]**

**Course Outcomes**

Students will

**CO1**: Be able to apply concepts of cellular network engineering in network design.

**CO2**: Understand various access mechanisms for medium sharing.

**CO3**: Understand various effects observed in propagation in wireless mobile communication systems.

**CO4**: Understand characterization methods and parameters of wireless communication channels.

**CO5**: Be able to understand and utilize various diversity techniques in wireless communication systems

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 2 | 3 |
| **CO2** | 1 | 1 | 1 | | |
| **CO3** | 2 | 2 | 2 | | |
| **CO4** | 1 | 3 | 3 | 1 | |
| **CO5** | 3 | 1 | 2 | 2 | |

**Contents**

Review of radio propagation and cellular engineering concepts: frequency reuse, frequency management and channel assignment, handoff and handoff strategies, trunking theory, Interference measurement and reduction, co-channel and other interference, coverage and capacity improvements, medium access techniques, FDMA, TDMA, CDMA, SDMA.

Large scale path loss, free space propagation model, propagation effects such as reflection, diffraction, scattering etc. Outdoor and indoor propagation models, ray tracing and coverage prediction. Small scale fading effects: time-variant impulse response model, channel correlation functions and spectral densities, coherence time, coherence bandwidth,

Main Characteristics of Fading Channels, Envelope and Phase Fluctuations, Slow and Fast Fading, Frequency-Flat and Frequency-Selective Fading, Modeling of Flat-Fading Channels, Multipath Fading, Rayleigh, Nakagami-m. Modeling of Frequency-Selective Fading Channels

Diversity, types of diversity: time diversity, space diversity, transmit and receive diversity, cooperative diversity, combining techniques for diversity reception: selection combining, maximal ratio combining, equal gain combining and their SNR analysis.

Introduction to optical wireless communication: concept of atmospheric turbulence, scintillation index, channel models, misalignment errors and their modelling, introduction to millimetre wave communication.

**Text Books**


1. Theodore S Rappaport: "Wireless Communications, Principles and Practice", Pearson Education Asia
2. Simon, Alouni, "Digital Communication over Fading Channels" John Wiley & Sons, 2005.


**Reference Books**


1. William C Y Lee. "Mobile Communications Engineering Theory and Applications", Second Edition, McGraw Hill Telecommunication.
2. William Stallings. "Wireless Communications and Networks", Pearson Education Asia.
3. Sumit Kasera, "3G Mobile Networks", McGraw Hills publication. 2007.
4. Simon Haykin and Michael Moher, " Modern Wireless Communications", Person Education.
5. Andreas F. Molisch, "Wireless Communication", Wiley Publishers. 2005.

**ECL520 Computational Electromagnetics [(3-0-0); Credit: 3]**

**Course Outcomes**

Students will

1. Understand ideas behind various simulation concepts used for electromagnetic simulations
2. Be familiar with and able to apply differential based approaches like FDM and FDTD.
3. Be familiar with and able to apply integral based approaches like MoM.
4. Be familiar with and able to apply approaches like FEM.
5. Apply these concepts to simulation of working of various components and systems.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 2 | 2 | 1 | 2 |
| **CO4** | 2 | 2 | 2 | 1 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 |

**Contents**

Introduction to electromagnetic fields: review of vector analysis, electric and magnetic potentials, boundary conditions, Maxwell's equations, diffusion equation, Poynting vector, wave equation.
Finite Difference Method (FDM): Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method
Finite Element Method (FEM): Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations
Method of Moments (MOM): integral formulation, Green's functions and numerical integration, other integral methods: boundary element method, charge simulation method
Applications of these methods for EM simulation of waveguides, micro-striplines and other planar components, antennas, scatterers, radars.

**Texts / References Books**


1. M. V. K. Chari and S. J. Salon, Numerical methods in electromagnetism, Academic Press.
2. M. N. O. Sadiku, Numerical techniques in electro-magnetics, CRC Press.
3. N. Ida, Numerical modeling for electromagnetic non-destructive evaluation, Chapman and Hall.

4. S. R. H. Hoole, Computer aided analysis and design of electromagnetic devices, Elsevier Science Publishing Co.
5. J. Jin, The Finite Element Method in electromagnetics, 2nd Ed., John Wiley and Sons.
6. P. P. Silvester and R. L. Ferrari, Finite elements for electrical engineers, 3rd Ed., Cambridge University Press.

**ECP518 Communication System Lab I [(0-0-2); Credit: 1]**

**Course Outcomes**

Student will be able to

1. Apply concepts of random variables and random processes to modeling the real-world communication systems.
2. Evaluate the effects of fading and Additive White Gaussian noise in wireless communication, through simulations.
3. Evaluate the performance metrics such as error and outage probabilities for any communication systems.
4. Analyze the achievable channel capacity for Gaussian and non-Gaussian communication channels.
5. Develop their interest in research related to communication systems.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 |
| **CO3** | 2 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 2 | 3 | 2 | 2 | 2 |

**Contents**

Introduction to standard random variables, Function of one and two random variables, and plotting and validating their PDFs with simulations.

Analysis and simulation of outage probability in various fading scenarios and AWGN noise. Analysis and simulation of error probability for MPSK and MQAM modulations in various fading scenarios and AWGN noise.

Channel capacity for additive white Gaussian noise channel

Performance analysis of advanced communication architectures such as cooperative communication, cognitive radio and free-space optical communication.

**ECP525 Signal Processing for Communication Systems Lab. [(0-0-2); Credit: 1]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. implement basic digital signal processing techniques for different applications related to communication
2. study different systems related to advanced digital signal processing
3. implement different transform algorithms like STFT, DWT for different applications
4. implement adaptive signal processing for different applications
5. implement basic digital processing algorithms in dedicated DSP platforms

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 2 | 3 | 1 | 2 | 2 |
| **CO5** | 3 | 3 | 1 | 3 | 3 |

**Contents**

Speech Synthesis and reconstruction using LPC model

Study of interpolation and Decimation

Synthesis & Analysis of signal using STFT

Synthesis & Analysis of signal using DWT.

Design and implementation of Wiener filter for different applications

Implementation of Speech signal analysis for cypress ARM kits

Implementation of Adaptive signal processing application on DSP kits Implementation of LMS algorithm for denoising application

Denoising using DTFT

**Text Books**


1. S. Haykin Adaptive Filter Theory 4th edition Prentice Hall
2. Khalid Sayood Introduction to Data Compression 2nd edition Morgan Kaufmann Publishers
3. R. M. Rao and A. S. Bopardikar Wavelet Transforms: Introduction to theory and Application 4th edition Pearson Edition


**Reference Books**


1. S. K. Mitra *Digital Signal Processing: A Computer Based Approach* 4th edition TMH
2. www. ti.com

**ECL533 Communication Theory [(3-0-0); Credits: 3]**

**Course Outcomes**

After completing this course, the student must demonstrate the knowledge and ability to:

1. decompose a signal in terms of its basis functions.
2. to evaluate the error performance of the various modulation techniques.
3. To design an optimum receiver for various modulation schemes.
4. find the maximum likelihood, maximum a posteriori probability and least-squares estimate of a parameter;
5. evaluate performance of decision making and estimation systems;

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 2 | 2 |

**Contents**

Representation of bandpass signals and system, signal space representation, representation of digitally modulated signals.

Memoryless modulations, linear and non-linear modulations with memory, spectral characteristics of digitally modulated signals: linear and non-linear modulations.

Optimum receivers for AWGN channels, waveform and vector channel models, optimal detection for the vector AWGN, Optimal detection for Band limited and power limited signaling.

Carrier and symbol synchronization: signal parameter estimation, carrier recovery and symbol synchronization in signal demodulation. Carrier phase estimation

Introduction, binary hypothesis test: decision criterion, performance, receiver operating characteristics. M-Hypotheses. Estimation theory: random parameters, Baye's estimation, likelihood ratio test, real parameter estimation, multiple parameter estimation.

**Text Books**


1. Proakis J. G., "Digital Communications", 4E, McGraw Hill, 2000.
2. Madhow U. "Fundamentals of Digital Communication", Cambridge University Press, 2008.
3. Van Trees H. L., Bell K. L. and Tian Z., "Detection Estimation and Modulation Theory (I)" 2E, Wiley, 2001.

**References**


1. Benedetto S. and Biglieri E., “Principles of Digital Transmission with Wireless Applications”, Kluwer Academic, 1999.
2. Gallager R. G., “Principles of Digital Communication”, Cambridge University Press, 2008.
3. Recent research articles to be suggested by the course instructor.

**ECL516 Converged Communication Networks [(3-0-0); Credit: 3]**
**Pre-requisites:**

**Course Outcomes**

Students will

1. be familiar with transfer of information (Data, Voice etc.) over Internet protocol.
2. Understand the principle of protocol architectures like SIP, H.323, MEGACO in IP based communications.
3. Understand and explain special media transport protocols in IP based communications.
4. be familiar with coding techniques of data in IP based communications.
5. be familiar with securities issues related with data transmission over IP.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 2 |
| **CO5** | 3 | 2 | 3 | 3 | 2 |

**Contents**

Review of circuit switched digital telephony, signaling and transmission, ISDN, SS7. Evolution of packet switched networks, Internet and LANs. The TCP/IP protocol stack.

Introduction to XoIP, network convergence, Needs of individual users, enterprises and network operators. How XoIP is expected to meet all these concerns.

Source coding (speech, audio and video coding) PCM, ADPCM, LP coding, CELP, RPE-LTP, adaptive sub-band coding, MPEG standards for audio and video coding.

Signaling protocols Review of H.323, MEGACO protocols, Session Initiation Protocol (SIP), detailed study of SIP.

Media Transport Need of special media transport protocols, RTP, RTCP, RTSP, QoS issues, routing, security etc.

**Books**


1. IP Telephony- O. Hersent, D. Gurle and JP Petit- Pearson Education Asia
2. Multimedia Communications – J. D. Gibson (Editor) – Harcourt India
3. IP Telephony – Bill Douskalis – Prentice Hall
4. Multicast Communication- R. Wittman, M.Zitterbart-Morgan Kaufman

**ECL409 Radio Frequency Circuit Design [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. be able to design passive matching networks.
2. be familiar with RF amplifiers in general
3. be able to design LNA, PA for a specified application.
4. design other circuits such as mixer, oscillator and phase locked loops
5. be familiar with A/D and D/A converters for RF applications

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 3 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 3 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 2 |

**Contents**

Characteristics of passive components for RF circuits. Passive RLC networks. Transmission lines. Two-port network modeling. S-parameter model. The Smith Chart and its applications.

Active devices for RF circuits: SiGe MOSFET, GaAs pHEMT, HBT and MESFET. PIN diode. Device parameters and their impact on circuit performance.

RF Amplifier design: single and multi-stage amplifiers. Review of analog filter design. Low-pass, high-pass, band-pass and band-reject filters. Bandwidth estimation methods. Voltage references and biasing.

Low Noise Amplifier design: noise types and their characterization, LNA topologies, power match vs noise match. Linearity and large-signal performance.

RF Power amplifiers: General properties. Class A, AB and C PAs. Class D, E and F amplifiers. Modulation of power amplifiers.

Analog communication circuits: Mixers, phase-locked loops, oscillators and synthesizers.

Design and performance characterization. Transceiver design.

**Text Books**


1. The Design of CMOS Radio Frequency Integrated Circuits, Lee Thomas H , Cambridge University Press.
2. Design of Analog CMOS integrated circuits, Razavi Behzad, McGraw Hill
3. Ludwig, Reinhold. *RF Circuit Design: Theory & Applications, 2/e*. Pearson Education India, 2000.

**ECP519 Communication System Lab II [(0-0-2); Credit: 1]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Understand about SDR and various hardware available for implementing wireless communication systems.
2. Understand the installation and working of hardware.
3. Understand the implementation of various popular modulation techniques using hardware.
4. Understand working of various wireless communication Technologies using hardware.
5. Develop their interest in research related to Wireless communication systems.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 2 | 3 | 3 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 3 |

**Contents**

Introduction to the Hardware (SDR) and its content. Importance of the Hardware and its applications. Installation of drivers and working with WiCOMM-T Kits, Implementing Image_Demo, Voice_Demo and QPSK using WiCOMM-T Kit, GSM, OFDM, CDMA, Equalizer

Understanding LabVIEW (software) & USRP (Hardware). Implementation of AM, DSB-SC, SSB, VSB, FM using LabVIEW. Fetch data/noise for finite duration and Continuously. Also display the IQ data along with PSD. Design a Transmitter using USRP. Implementing modulation techniques using USRP. (Various types of PSK, QAM and PAM)

**ECD501 Project Phase I [(0-0-0); Credit: 3]**

**Pre-requisites:**

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | | | | |
| **CO2** | | 2 | | | |
| **CO3** | 2 | | | | |
| **CO4** | | | 2 | | |
| **CO5** | | | | 1 | 3 |

**Course outcomes**

Students will

1. get an opportunity to apply knowledge of several courses in developing a new algorithm or circuit or a larger system.
2. implement innovative ideas and publish them as a research paper or file a patent.
3. learn working as a team.
4. acquire additional skills otherwise not covered in the curriculum
5. gain practical knowledge about the topic including social, commercial, manufacturing, testing, measurements, simulation, marketing and legal issues (as applicable).

**ECD502 Project Phase II [(0-0-0); Credit: 9]**

**Pre-requisites:**

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | | | | |
| **CO2** | | 3 | | | |
| **CO3** | 3 | | 3 | | |
| **CO4** | | | 3 | | |
| **CO5** | | | | 3 | 3 |

**Course outcomes**

Students will

1. get an opportunity to apply knowledge of several courses in developing a new algorithm or circuit or a larger system.
2. implement innovative ideas and publish them as a research paper or file a patent.
3. learn working as a team.

4 acquire additional skills otherwise not covered in the curriculum

5. gain practical knowledge about the topic including social, commercial, manufacturing, testing, measurements, simulation, marketing and legal issues (as applicable).

## ELECTIVE COURSES

**ECL424 Optical Communication [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

1. Familiarity with basic concepts and theory of Optical Communication.
2. Ability to demonstrate OPCOMM components, assemble them and solve problems on Optical Communication system.
3. Ability to design, implements, analyzes and maintains optical communication system
4. Knowledge of different source of light as well as receiver nd their comparative study
5. To get idea about power budget and ultimately be an engineer with adequate knowledge in optical domain

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 2 | | 2 | 1 |
| **CO2** | | 2 | 2 | | |
| **CO3** | 1 | 2 | | 3 | 1 |
| **CO4** | | | 2 | 2 | |
| **CO5** | | 2 | 2 | 3 | |

**Contents**

Optical Fiber: Basic concepts of optical communication. The nature of light. Light as an Electromagnetic Wave, Polarisation, Interference. Transmitting light on a Fibre Refractive index, Fibre refractive index profiles, Modes of propagation. Light Propagation in Multimode Fibre, Snell's Law Critical Angle, Numerical aperture.

Optical Sources: Light Emitting Diodes (LEDS), The Semiconductor Junction Diode, Construction and Operation of LED's , Heterojunctions (Practical LED's) , Characteristics of LED'S, Lasers, Principle of the LASER, Semiconductor Laser Diodes.

Optical Detectors: Photoconductors, Photodiodes, P-N Diodes, P-I-N Diodes, Schottky-Barrier Photodiodes, Avalanche Photodiodes (APDS), Hetero-interface Photodetectors, Travelling Wave photo detectors, Phototransistors.

Optical Communication Systems: Point-to-point Transmission Systems, Modulation techniques, On-off key, Multi state coding, Forward Error correction, Receiving the signal, Timing recovery, Bandwidth Occupancy.

**References**


1. “Optical Fibre Communication Practice and Principles”, Senior
2. “Fibre Optic Communication”, D. C. Agrawal
3. “Optical Communication”, Keiser


**Text Books**


1. Optical Fibre Communication Practice and Principles, J. Senior
2. Fibre Optic Communication , D. C. Agrawal
3. Optical Communication , Keiser


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**ECP424 Optical Communication Lab. [(0-0-2); Credit: 1]**

**Pre-requisites:**

**Course Outcomes**

1. Familiarity with basic concepts and theory of Optical Communication.
2. Ability to measure different optical fiber parameter.
3. Ability to measure and understand different characteristics of source and receiver
4. Visualise different scheme of communication in optical medium.
5. ability to design a optical communication link

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 1 | | | 1 |
| **CO2** | | 2 | | 2 | |
| **CO3** | | 2 | | 2 | |
| **CO4** | | | | 2 | |
| **CO5** | | | | | |

**Course Contents**

1. Measurement of propagation losses in an Optical Fiber
2. Measurement of Numerical Aperture of an Optical Fiber using 660 nm LED
2) Study of V-I , I-P characteristics of laser and V-I characteristics of 660 nm LED
   (a). Study of Fiber optic transmission sensor
   (b). Study of Fiber optic reflection sensor
   (c). Transmission of light through fiber with gaps
3) Setting up of Fiber optic digital link
4) Setting up of Fiber optic analog link
5) Study and measurement of Bit Error Rate (BER)
6) Study of Pulse width modulation and demodulation
7) Study of Pulse amplitude modulation and demodulation
8) Study of Pulse position modulation and demodulation

**ECL402 Comm. Net. & Network Applications [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Be able to distinguish between various network topologies and types of switching
2. Be knowing various medium access protocols and network hardware components
3. Be knowing details of network layer protocols IPv4 and IPv6
4. Be familiar with various protocols used for network control, management and testing.
5. Be conversant with application layer of internet (web technology)

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 1 | 2 | 1 |
| **CO2** | 1 | 2 | 1 | 2 | 1 |
| **CO3** | 1 | 2 | 2 | 2 | 1 |
| **CO4** | 1 | 2 | 1 | 1 | 1 |
| **CO5** | 1 | 2 | 1 | 2 | 1 |

**Contents**

Networks and services; network topologies; switching methods; network evolution; concept of layered architecture; the OSI model; the TCP/IP model; standardization and standards organizations. Study of telephone network; PCM-TDM based IDN; circuit switching; space and time division switching; signaling methods; store-and-forward switching. ISDN fundamentals; SS#7; Frame relay and ATM networks; SONET and SDH;

LANs and MAC protocols; ALOHA, slotted ALOHA, CSMA and CSMA-CD protocols; IEEE 802.3 protocol and MAC frame format. Details of 802.3 hardware options; 100 Mbps and 1000 Mbps Ethernet LANs, switches, bridges and VPN; Wireless LANs; LAN applications; client-server architecture;

Network Layer: services offered to the transport layer, internal organization as datagram or virtual circuit subnets; routing algorithms; congestion control; internetworking; Study of IPv4 and IP v6, DNS and Internet routing protocols.

Transport Layer: Design issues; study of TCP; connection setup and removal; flow control; reliable and efficient delivery, timer management. The TCP/IP protocol stack: ICMP, IGMP, UDP, BOOTP, DHCP etc.

Network applications: World Wide Web and HTTP; Web servers and browsers, Content Engines; FTP and TFTP; SMTP and MIME; DNS; multimedia networking; streaming stored audio and video; Internet audio and video communications.

**Books**


1. Communication Networks ; Leon-Garcia and Widjaja TMH 3e
2. Computer Networks, a systems approach Peterson and Davie- Morgan Kauffman, Harcourt India 3e ,
3. Computer Networks , Tanenbaum A. S.; PHI, 4e,
4. Data Comuncation and Networking , B. Forouzan, TMH ,4e
5. Data and Computer Communication, Stallings William, PHI, 6e
6. Computer Networking, a top-down approach featuring the Internet; Kurose and Ross ; Addison Wesley, (Low Price Edition)
7. Communications and Networking Technologies- Gallo and Hancock ;Thomson Learning 2e
8. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill

**ECP402 Comm. Net. & Network Applications Lab [(0-0-2); Credit: 1]**

**Pre-requisites:**

Students will

1. Be able to configure user machines, switches and routers
2. Perform network functioning analysis tools using packet sniffer tools such as WireShark.
3. Be able to gather information on status, configuration and settings of various equipment on the network.
4. Be able to use the network for file sharing, printer sharing etc.
5. Be able to understand working of higher layer protocols.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 1 | 1 | 2 |
| **CO2** | 1 | 2 | 3 | 1 | 1 |
| **CO3** | 1 | 2 | 2 | 1 | 1 |
| **CO4** | 1 | 2 | 2 | 2 | 1 |
| **CO5** | 2 | 2 | 1 | 1 | 2 |

**Contents**

1. Using utilities such as ‘net help’, ‘netstart’, ‘netview’ etc.
2. Study of networking devices, topologies and IEEE 802 series standards
3. Gathering information about NIC of a PC.
4. TCP/IP diagnostics and configuration using ‘ping’, ‘ipconfig’ etc.
5. Files sharing in LANs
6. User login and security settings
7. WireShark or similar open source packet sniffers and their use
8. Network protocol analyzer equipment.

**ECL416 Fuzzy Logic and Neural Networks [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course outcomes**

Students will

1. Understand the concept of fuzziness involved in various systems.
   Compare biological and Artificial Neural networks.
2. Be provided adequate knowledge about fuzzy set theory and mathematical derivations.
3. Comprehend the fuzzy logic control to design the fuzzy controllers using MATLAB and SIMULINK.
4. Study different configurations of Neural networks..
5. Design Neural Networks for applications in pattern recognition problems and curve fitting algorithms.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 2 | | 2 | 1 |
| **CO2** | | 2 | 2 | | |
| **CO3** | 1 | 2 | | 3 | 1 |
| **CO4** | | 2 | 2 | | |
| **CO5** | | 2 | | 3 | |

**Contents**

Crisp sets & Fuzzy Sets : Introduction, Concepts, Fuzzy operations, General Aggregation of operation, Fuzzy relations, Binary relations, Equivalence & similarity relations, Fuzzy relation equation. Applications : Natural, Engineering, Management & Decision making & Computer science. Supervised and Unsupervised Learning, Multilayer feed forward networks, back propogation algorithm. RBF networks, RLS algorithm, Single layer feedback networks, Hopfield networks, Applications of ANN. SOM,

**Books**


1. Fuzzy Sets Uncertainty & Information; George Klir, Prentice Hall, 2e.
2. Introduction to Artificial Neural Systems, Zurada J. M, West Publishing Co, 2e.
3. Communication Electronics- Principle and Applications, Frenzel, Publisher TMH 3e.
4. Neural Networks and Fuzzy Systems; B.Kosko; Publisher Prentice Hall, 3e.
5. Elements of Neural Networks; Mehrotra K., Mohan C.K., Ranka S.; Publisher

**ECL418 Network Planning and Management [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Understand applications of traffic analysis to network planning
2. Understand various procurement and installation procedures.
3. Understand operation and maintenance systems for telecom networks
4. Design an enterprise network based on the requirements of an organisation.
5. Understand protocols and applications for enterprise network management and diagnosis

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 2 |
| **CO2** | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 2 | 3 | 2 |

**Contents**

Network traffic data analysis and forecasting, resource planning, procurement and installation

Telecom network operation and maintenance system. Case studies of ISDN, ATM, GSM, CDMA networks.

Enterprise need analysis and LAN design, component selection, procurement and installation.

Network management issues such as configuration management, fault and maintenance management, security and access management.

Management protocols such as SNMP, web based management tools such as Netconf, management protocol issues such as scalability, efficiency, effectiveness etc.

**Text**

1. Subramanian ; Network Management ; Addison Wesley (Low Price Edition)
2. McCabe J.D., Network analysis, architecture and design, Elsevier
3. FitzGerald J., Dennis A., Business Data Communications and networking,

**ECL513 Synchronization and Tracking [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

1. acquire working knowledge of network synchronization methods
2. able to design PLL as required in a system.
3. be able to simulate and analyze carrier synchronization methods
4. be able to model and simulate methods for symbol timing recovery
5. be familiar with speech system in CDMA and OFDM based systems

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 3 | 2 |
| **CO5** | 2 | 1 | 2 | 2 | 3 |

**Contents**

Network synchronization for TDM networks, timing references and their distribution, hierarchical systems, mutual synchronization.

PLL: Design and analysis of PLL, Loop modeling; linear and non-linear, acquisition and tracking range. Static and dynamic performance. Phase noise and jitter.

Carrier Synchronization methods: Costas Mth power loop, phase ambiguity issues, advances in carrier synchronization

Symbol timing recovery: Early-late gate method, steady state and transient response, modeling and simulation.

Code acquisition and tracking techniques for spread spectrum methods

Carrier synchronization issues in OFDM. Performance degradation due to frequency offset error.

Chaotic synchronization

**Text Books**

1. Proakis John; Digital communication(Third Edition); Tata- McGraw-Hill.
2. Haykin Simon; Communication systems (Fourth Edition); Wiley.
3. Korsch H.J., Jodl H.J., Chaos, Springer-Verlag

**ECL428 Industrial Communication Systems [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

1. Familiarity with basic concepts of various interfaces.
2. Ability to design different systems for interfacing.
3. Ability to measure and understand different characteristics of source and receiver
4. Visualise different scheme of communication in industrial environment.
5. ability to design a practical communication link

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 2 | 2 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 2 | 2 | 3 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 2 |

Interface: Introduction, principles of interface, serial interface and its standards.
Parallel interfaces and buses. Fieldbus: Use of field buses in industrial plants, functions, international standards, performance, use of Ethernet networks, fieldbus advantages and disadvantages. Fieldbus design, installation, economics and documentation.
Instrumentation network design and upgrade: Instrumentation design goals, cost optimal and accurate sensor networks. Global system architectures,advantages and limitations of open networks, HART network and foundation fieldbus network.
PROFIBUS-PA: Basic, architecture, model, network design and system configuration. Designing PROFIBUS-PA and foundation. Fieldbus segments: general considerations, network design, MODBUS.

**Text Books**

1. Noltingk B.E. “Instrumentation Reference Book” . 2nd E dition. Butterwort Heinenmann. 1995.
2. B.G. Liptak. Process software and digital networks, 3rd Edition. CRC press, Florida.

**Reference Books**

1. John Park ,Steve Mackay “Practical Data acquisition for Instrumentation and control systems” Elsevier ,2003
2. Creed Huddleston “Intelligent sensor Design Using the Microchip dsPIC” Elsevier ,2007

**ECP440 Cyber Laws and Telecom Regulation Workshop [(0-0-2); Credit: 1]**

**Pre-requisites:**

**Course Outcomes**

1. Familiarity with basic concepts of telecom regulation.
2. Appreciation of functioning of various regulatory authorities.
3. Understanding of issues related to tariff plans.
4. Ability of Analysis of case studies.
5. An overview of cyber laws

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 3 | 2 |
| **CO2** | 2 | 3 | 3 | 3 | 2 |
| **CO3** | 2 | 3 | 3 | 3 | 2 |
| **CO4** | 2 | 3 | 3 | 3 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 2 |

**Contents**

Telecom regulatory authorities, objectives, functioning. Mobile phone tariff plans, spectrum regulation, privacy and consumer protection.

Laws related with cyber crimes, financial crimes through electronic network, prevention of abuse, harassment etc.

[Students are expected to take up various case studies and make presentations.]

**References**

1. www.trai.gov.in/

**ECP441 Network Standards Workshop [(0-0-2); Credit: 1]**

**Pre-requisites:**

**Course Outcomes**

1. Familiarity with basic concepts of standardization.
2. Appreciation of functioning of various standard development organizations.
3. Understanding of issues related to standardization of cabling .
4. Ability of Analysis of case studies.
5. An overview of technologies influencing future standards

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 1 | 2 | 2 | 3 | 1 |
| **CO4** | 1 | 2 | 2 | 3 | 1 |
| **CO5** | 1 | 2 | 2 | 2 | 1 |

**Contents**

Need of standardization in communication technology, social, economical, commercial and managerial issues. Standardization in ETSI and ITU, 3GPP and 3GPP2, IETF, IEEE
Structured cabling and best practices in cabling installation. Installation of LAN wiring, optical fiber cables, installation standards for telecom cabling.

**References**


1. www.ieee.org
2. www.ietf.org
3. www.etsi.org
4. www.3gpp.org
5. www.itu.org
6. www.3gpp2.org
7. www.iso.org
8. www.tiaonline.org

**ECP442 Software Engineering Workshop [(0-0-2); Credit: 1]**

**Pre-requisites:**

**Course Outcomes**

1. Familiarity with basic concepts of software engineering.
2. Appreciation of need of software engineering.
3. Understanding of issues related to tools for software engineering.
4. Ability of Analysis of case studies.
5. An overview of technologies influencing future practices and standards

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 3 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 1 | 1 | 1 |
| **CO3** | 1 | 2 | 1 | 1 | 1 |
| **CO4** | 2 | 2 | 1 | 1 | 2 |
| **CO5** | 1 | 1 | 2 | 1 | 1 |

**Contents**

Software requirements analysis, design documentation and business rules. Software development, testing, maintenance, configuration management. Software engineering tools and methods, Computer Aided Software Engineering and Software development methodology, Software quality. Software project management. Software engineering concepts as applied to communication related software development

[Students are expected to take up various case studies and make presentations.]

**References**


1. Pressman, Roger S (2005). Software Engineering: A Practitioner's Approach (6th ed.). Boston, Mass: McGraw-Hill. ISBN 0072853182.
2. Sommerville, Ian (2007) [1982]. Software Engineering (8th ed.). Harlow, England: Pearson Education. ISBN 0-321-31379-8.
3. Jalote, Pankaj (2005) [1991]. An Integrated Approach to Software Engineering (3rd ed.). Springer. ISBN 0-387-20881-X.
4. Ghezzi, Carlo; Mehdi Jazayeri, Dino Mandrioli (2003) [1991]. Fundamentals of Software Engineering (2nd (International) ed.). Pearson Education @ Prentice-Hall.
5. IEEE Computer Society, Guide to the Software Engineering Body of Knowledge (SWEBOK) http://www.computer.org/portal/web/swebok

**ECL526 Computer Vision [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course outcomes**

Students will

1. know computer vision fundamentals (image formation and image processing).
2. be familiar with different feature extraction techniques and their applications.
3. be conversant with basics of image segmentation and different image segmentation algorithms.
4. be familiar with basic pattern recognition methods.
5. be conversant with basics of multi view imaging and depth estimation.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 2 | 1 | 3 |
| **CO2** | 3 | 1 | 2 | 1 | 3 |
| **CO3** | 3 | 1 | 3 | 1 | 3 |
| **CO4** | 3 | 1 | 3 | 3 | 3 |
| **CO5** | 3 | 1 | 3 | 1 | 3 |

**Contents**

Introduction about computer vision: What is computer vision, advantages and disadvantages of computer vision, general applications of computer vision.

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Pattern Analysis: Clustering: K-Means, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Computational imaging: Image sensor, noise, HDR, super resolution, blur removal, compressive sensing, Depth estimation and Multi-camera views: projective geometry, binocular stereo, stereo matching, Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.

Case studies of computer vision projects such as medical image analysis, 3D modeling from LiDar point clouds etc.

**Text Books**

1 Shapiro and Stockman Computer Vision Illustrated edition Prentice Hall

2. Rafael C. Gonzalez and Richard E. Woods Digital image processing 3rd edition Pearson Education

3. Christopher Bishop Pattern Recognition and Machine learning Illustrated edition Springer

4 Richard Hartley and Andrew Zisserman Multiple View Geometry in Computer Vision 2nd edition Cambridge University Press

**Reference Books**

1. Richard Szeliski Computer Vision: Algorithms and Applications Springer

**ECP526 Computer Vision Lab [(0-0-2); Credit: 1]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. be able to implement basic image evaluation methods
2. be able to implement different feature detector algorithms for images
3. implement basic segmentation algorithms on grayscale images
4. implement basic clustering & dimensionality reduction techniques
5. implement 3D reconstruction using 2D images

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 1 | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 1 | 3 |

**Contents**

Histogram plotting of an Image. Implementation of Histogram equalization

Design and implementation of simple filters like averaging, sharpening & edge detector filters

Design and implementation of Harris corner detector

Design and implementation of SIFT algorithm for image matching

Implementation of simple segmentation algorithms

Implementation of PCA for dimensionality reduction

Implementation of simple clustering algorithms

Implementation of 3D reconstruction algorithms using stereo images

**Text Books**


1 Shapiro and Stockman Computer Vision Illustrated edition Prentice Hall

2. Rafael C. Gonzalez and Richard E. Woods Digital image processing 3rd edition Pearson Education

3. Christopher Bishop Pattern Recognition and Machine learning Illustrated edition Springer

4. Richard Hartley and Andrew Zisserman Multiple View Geometry in Computer Vision 2nd edition Cambridge University Press


**Reference Books**


1. Richard Szeliski Computer Vision: Algorithms and Applications Springer

**ECP409 Radio Frequency Circuit Design Lab.[(0-0-2); Credit: 1]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. be able to analyze an impedance transformation network using a software tool and use the circuit in their design.
2. be able to design physical lay-out of a passive component and evaluate its performance with software tools such as ADS or Microwave Office.
3. will be able to characterize an RF component or circuit using S-parameter matrix
4. be able to design RF amplifier and related circuits and evaluate the performance using software tools.
5. Be able to design mixers and oscillators and evaluate performance using software tools

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 |
| **CO4** | 2 | 3 | 3 | 3 | 2 |
| **CO5** | 2 | 3 | 3 | 3 | 2 |

**Contents**

Phase-I: Simulation of impedance transformation passive networks

1. L- section upward transformation
2. L-section, downward transformation
3. Π- circuit
4. T-circuit
5. Tapped capacitor resonator
6. Tapped inductor resonator
7. Double tapped resonator

For every network, plot the Zin as function of frequency and load resistance Rs.

Phase-II: Simulation of passive RF components.

(Layout design and simulation, circuit models and parameter extraction, circuit simulation)

1. Design of resistor using poly-silicon over field oxide.
2. Parallel plate capacitor using poly-insulator-poly and metal-insulator-metal layers.
3. Lateral flux capacitors (inter-digitated, simple fractal)
4. Spiral inductor and transformer. (Use of Razavi's formula and Lee's formula)
5. Active resistor and MOS capacitor using MOSFETs

Phase-III: S parameter characterization of passive and active components

Using the advanced micro-strip trainer, find the S-parameters of the following components

1. Patch antenna (transformer feed and inset feed)
2. Low-pass filter
3. Band-pass filter
4. Band-reject filter
5. Ring resonator
6. Power divider (with and without isolation resistor)
7. Rat race hybrid ring coupler
8. Parallel line coupler
9. Branched line coupler
10 Amplifier

Phase-IV Design and simulation of active circuits

1. Common Source and Common Gate CMOS amplifier
2. Differential amplifier
3. Single ended LNA
4. Double ended LNA
5. Power amplifiers class A, B, C
6. Power amplifiers class D, E and F
7. Gilbert mixer
8. Colpitt and Hartley oscillators
9. Negative frequency oscillators

**ECL406 Mobile Communication Systems [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. be aware of generations of wireless mobile communication technologies
2. be conversant with how various decisions were made while evolving the mobile communication system standards.
3. be aware of functioning of mobile communication network
4. be familiar with features of wireless LAN technologies
5. be familiar with Bluetooth communication technology

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 3 | 2 |
| **CO2** | 1 | 3 | * | * | * |
| **CO3** | 1 | 3 | 2 | 1 | 2 |
| **CO4** | 1 | 1 | 1 | 1 | * |
| **CO5** | 1 | 1 | 1 | 1 | * |

**Contents**

The second generation (2G) systems

GSM: services, features, architecture, radio link, channel types, frames, call handling

CDMA IS95: forward and reverse channels, system architecture, call handling.

2.5G systems

GPRS: data rates, basic services, system architecture, protocols, coding schemes, mobility management, hardware and software components

EDGE: evolution, advanced modulation methods, radio transmission and data rates, services and protocols.

The 3G systems: Introduction, evolution of 3G networks, ITU IMT 2000,

CDMA 2000: bandwidth, chip rate, channels, spreading and modulation, power control, soft handoff, EV-DO, EV-DV

UMTS: radio access network, spreading and modulation, channels, core network.

Wireless LANs

IEEE 802.11 system and protocol architecture, physical layer and MAC, options like 802.11b, a g etc. and their purpose.

Bluetooth: User scenarios, layered architecture, link management, L2CAP, SDP, IEEE 802.15Mobile Communication

**Text Books**

1. Jochen Schiller, “Mobile Communication 2nd Edition”, Pearson education.

**Reference Books**

1. Theodre S. Rappaport, “Wireless Communication: Principles and Practices”, Pearson Education.
2. Wireless and Mobile Network Architecture Yi-Bing Lin and Imrich Chlamtac Wiley Publication.
3. Gordon L., Stuber Kluwer , “Principles of Mobile Communication 1st Edition ”, Academic Publishers, Norwell, Ma, USA
4. Kasera Sumit, Narang Nishit , “3G Mobile Network: Architecture, Protocol and Procedures”, Tata McGraw Hill.
5. Sumit Kasera, “3G Mobile Networks”, McGraw Hills publication. 2007.
6. Simon Haykin and Michael Moher, “ Modern Wireless Communications”, Person Education.

**ECL410 Satellite Communication [(3-0-0); Credits: 3]**

**Course Outcomes**

Students will

1. Be conversant with orbital aspects of satellite communication
2. Be able to design satellite link
3. Be knowing about digital satellite links
4. Be familiar with multi-access schemes
5. Be familiar with earth station technology

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 2 | | | |
| **CO2** | 1 | 2 | 3 | | |
| **CO3** | | 2 | 3 | | |
| **CO4** | | | 3 | | |
| **CO5** | | | 2 | | 2 |

**Contents**

Orbital aspects of satellite communication, Orbit mechanisms, Equation of orbit, Locating satellite in orbit, Orbital elements, Orbital area coverage, Look angles, Slant range,
Space craft subsystems, Attitude and orbit control system, Telemetry tracking and command system (TTC), Power subsystems, Antennas, Reliability
Satellite link design, System noise temperature, G/T ratio, Down link design, Uplink design, Link for specified (C/N) base-band noise signal.
Digital Satellite Links, Frequencies and channel allocations, Modulation techniques, QPSK, QAM, BER analysis, medium access methods for satellite communication.
Earth station technology, Earth station design for low system noise temperature. Equipment for earth stations, LNA and HPA.
VSAT systems- overview of VSAT systems, Access control protocols, multiple access selection, modulation, coding and interference issues .

**Books**


1. Satellite communication , Timothy Pratt, Charles Bostian, Jeremy Allnut, John Willey and Sons Inc. Second edition
2. Satellite Communication Systems Engineering, W. L. Pritchard, H.G. Suyderhoud, R.A. Nelson, Pearson Education Second edition

3. Advanced Electronic communications, Wayne Tomasi, Prentice Hall of India Pvt. Ltd Fifth edition
4. Electronic Communication Systems Frank.R. Dungan, International Thomson Publishing Company Third edition.
5. Satellite Communication, Roddy Second edition .
6. Satellite Communication Technology , Dr. K. Miya, Second edition

**ECL411 Digital Image Processing [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. understand and explore importance of Digital Image Processing.
2. be able to extend the theory concepts of Digital Signal Processing further to Digital Image Processing.
3. physically understand concepts of digital image enhancement and filtering in spatial domain.
4. implement frequency domain filters for image processing applications.
5. visualize basic computer vision algorithms using the learned Image Processing concepts.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | | 2 | | |
| **CO2** | 2 | | 3 | | |
| **CO3** | 3 | | 2 | 1 | |
| **CO4** | | | 2 | 2 | 1 |
| **CO5** | 2 | 1 | 2 | 2 | 2 |

**Contents**

Elements of visual perception, Digital Image fundamentals, Basic image processing steps, Image Transforms, Image enhancement in spatial and frequeny domain, linear gray level transformations, Histogram equalization and specification ,smoothing & sharpening spatial filters, Image degradation models ,image restoration, inverse filtering, Wiener filtering. Image reconstructions from projections, radon transform, projection theorem of computerized tomography Morphological image processing ,dilation ,erosion, Basic morphological algorithms ,thinning algorithms Edge detection ,Edge linking & Boundary Detection ,watershed segmentation algorithm , Introduction to object recognition., colour image processing ,RGB and HSI color models, Gray level to color transformations

**Text Books**

1. Digital Image Processing Gonzalez R.C. and Woods R.E., Pearson, Second

**Reference Books**

1. Digital Image Processing Pratt W.K., Wiley, Third
2. Fundamentals of Digital Image Processing, A.K.Jain, PHI

**ECL413 Adaptive Signal Processing [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. review the basic concepts related to vector space and Eigen analysis
2. review the basic concepts of stochastic signals and statistics of stationary signal
3. implement Wiener filter using different LMS algorithms
4. be familia with RLS algorithm
5. able to design adaptive filters for different applications

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 1 | 1 |
| **CO2** | 3 | 1 | 3 | 2 | 2 |
| **CO3** | 3 | 1 | 2 | 2 | 3 |
| **CO4** | 3 | 1 | 2 | 2 | 2 |
| **CO5** | 3 | 1 | 1 | 3 | 2 |

**Contents**

Vectors, Matrices and Eigen Analysis. Application to adaptive signal processing. Stochastic Processes, Ensemble average, mean, average power, auto and cross correlation functions, stationarity and white noise, Auto-regressive process. Least Squares and LMS algorithms, Normal equations, properties. Eigen System decomposition. Gradient search technique, convergence properties of LMS. Normalized LMS algorithm. Recursive solution techniques, RLS algorithm. Application to noise cancellation, modeling of physical processes, communications.

**Text Books**

1 S. Haykin Adaptive Filter Theory Fourth Edition Prentice Hall

2. B. Widrow and S. D. Sterns Adaptive Signal Processing Pearson Education

**Reference Books**

1. M. J. Larrimore, C. R. Johnson and J. R. Treichler Theory and Design of Adaptive Filters publisher

**ECL419 Wireless Sensor Networks [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course outcomes**

Students will

1. Be introduced to wireless sensors which have applications in many fields.
2. be able to design wireless sensor networks for an application after completion of the course.
3. Be aware of emerging research areas in the field of sensor networks after successful completion of this course.
4. Be familiar with various MAC protocols used for different communication standards used in WSN
5. Students can explore new protocols for WSN

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 3 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 1 | 3 | 2 |
| **CO3** | 2 | 1 | 1 | 3 | 1 |
| **CO4** | 1 | 1 | 2 | 2 | 1 |
| **CO5** | 3 | 2 | 1 | 2 | 1 |

**Contents**

Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks

Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks

Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee,

Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.

Design Principles for WSNs ,Gateway Concepts Need for gateway ,WSN to Internet Communication, Internet to WSN Communication.

Single-node architecture, Hardware components & design constraints,

Operating systems and execution environments, introduction to TinyOS and nesC.

**Text Books**

1 Waltenegus Dargie , Christian Poellabauer, Fundamentals Of Wireless Sensor Networks Theory And Practice By John Wiley & Sons Publications

**Reference Books**

1. Sabrie Soloman, SENSORS HANDBOOK by Mc Graw Hill publication.
2. Feng Zhao, Leonidas Guibas, Wireless Sensor Networks, Elsevier Publications.
3. Kazem Sohrby, Daniel Minoli, Wireless Sensor Networks: Technology, Protocols and Applications, Wiley-Inderscience
4. Philip Levis, And David Gay Tinyos Programming by Cambridge University Press.
5. Jun Zheng, Abbas Jamalipour, Wireless Sensor Networks by Wiley.

**ECL420 Smart Antennas [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Be acquainted with fundamentals and terminology of antenna arrays.
2. Be familiar with working of smart arrays.
3. Be able to utilize various signal processing techniques for smart arrays.
4. Be conversant with Beam Space Processing Techniques for smart antenna.
5. Be able to learn various adaptive processing techniques for smart antenna.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 1 | | 2 | |
| **CO2** | 3 | | | 2 | |
| **CO3** | | 1 | 3 | | 2 |
| **CO4** | | 1 | 3 | | 2 |
| **CO5** | | 1 | 3 | | 2 |

**Contents**

Array Antenna Fundamentals: Linear Arrays, Array Weighting, Beamsteered Arrays, Circular Arrays ,Fixed Beam and Sectorized Arrays. Sidelobe Cancellors , Retrodirective Arrays.

Narrowband Processing: Signal Model, Steering Vector Representation, Conventional Beamformer, Source in Look Direction, Directional Interference, Random Noise Environment, Signal-to-Noise Ratio, Null Steering Beamformer, Optimal Beamformer: Unconstrained Beamformer, Constrained Beamformer, Output Signal-to-Noise Ratio and Array Gain, Optimization Using Reference Signal, Beam Space Processing,

Adaptive Processing : Sample Matrix Inversion Algorithm, Unconstrained Least Mean Squares Algorithm, Gradient Estimate, Covariance of Gradient, Convergence of Weight Vector, Weight Covariance Matrix, Transient Behavior of Weight Covariance Matrix, Excess Mean Square Error, Misadjustment, Normalized Least Mean Squares Algorithm, Constrained Least Mean Squares Algorithm

Channel Characterization ,Channel Impulse Response, Slow Fading; Fast Fading; Fast Fading Modeling ,Spreading , Channel Equalization. Methods for Optimizing the Location of Base Stations

for Indoor Wireless Communication, Identification and Elimination of Multipath Effects, Signal Enhancement in Multiuser Communication

**Books**


1. Smart Antenna by L.C. Godara, CRC Press
2. Smart Antennas for Wireless Communications By Frank Gross, McGraw hill
3. Smart Antennas, Tapan A. Sarkar ,M. C. Wicks, M. Salazar-Palma, R. J. Bonneau , Wiley
4. Introduction to Smart Antennas by Balanis Constantine A. , Morgan & Claypool

**ECL427 Broadband Communication [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Be conversant with orbital aspects of satellite communication
2. Be able to design satellite link
3. Be knowing about digital satellite links
4. Be familiar with multi-access schemes
5. Be familiar with multi-carrier communication systems

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 3 | | | 2 |
| **CO2** | 1 | | | 3 | 1 |
| **CO3** | 1 | 2 | | | 1 |
| **CO4** | 1 | | 3 | | 1 |
| **CO5** | 1 | 3 | | | |

**Contents**

Satellite Communication Systems

Orbital aspects of satellite communication, Attitude and orbit control system, Telemetry tracking and command system (TTC), Power subsystems, Antennas, Reliability

Satellite link design, System noise temperature, G/T ratio, Down link design, Uplink design, Link Design for a specified (C/N) Performance.

Digital Satellite Links, Frequencies and channel allocations, Modulation techniques, QPSK, QAM, BER analysis, medium access methods for satellite communication.

Multicarrier communication systems:

OFDM, MIMO systems, space-time coding, WiFi, WiMAX, UWB systems

**Text Book:**

1. Timothy Pratt, Charles Bostian, Jeremy Allnut,"Satellite communication" John Willey and Sons Inc. Second edition

**Reference Books:**

1. W. L. Pritchard, H.G. Suyderhoud, R.A. Nelson, "Satellite Communication Systems Engineering" Pearson Education Second edition
2. Wayne Tomasi "Advanced Electronic communications" PHI Learning, Fifth edition

3. Frank.R. Dungan," Electronic Communication Systems" International Thomson Publishing Company Third edition
4. J. Proakis, "Digital Communication" 4e, TMH
5. Simon Haykin, "Communication Systems", 4e, John Wiley

**ECL511 Non-linear System Modeling [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course outcomes**

Students will

1. Be familiar with non linear systems and methods of analysis of the non linear systems.
2. Be able to do stability analysis of non linear systems
3. Be aware of different nonlinear phenomena
4. Be familiar with chaos based communication
5. Be aware of chaos in different signal processing applications

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | | | 1 | 1 |
| **CO2** | | 2 | | 1 | 2 |
| **CO3** | | | 2 | | 1 |
| **CO4** | 1 | | | 3 | 1 |
| **CO5** | | | | 1 | 2 |

**Contents**

Introduction to nonlinear systems, analysis by phase plane and describing function methods. Nonlinear circuits.

Lyapunov stability theory. The Lure problem: Popov's method, circle criterion. Hyperstability. Hamiltonian, Lagrangian and gradient systems

Introduction to dynamical systems, examples of discrete and continuous dynamical systems, Lorenz attractor, Logistic map, Bifurcation ,Chaos in dynamical system

Chaos based communication: chaotic modulation, chaotic multiplexing, chaotic masking. Chaotic oscillator, Chaotic synchronization methods.

Chaos and signal processing: chaos based noise modeling for adaptive filtering, invertible chaotic encryption ,chaos based jamming. Fractal basics, iterated function systems, fractal applications.

**Text Books**

1 Khalil, Hassan K. Nonlinear Systems 3rd Edition Prentice Hall

2. Steven H, Strogatz Nonlinear dynamics and chaos: with applications to physics, biology chemistry and engineering Addison Wesley

3 M. Vidyasagar Nonlinear Systems 2nd Edition Prentice Hall

**Reference Books**

1. Lawrence Perko Differential Equations and Dynamical Systems Second Edition Springer

2. V. M. Popov Hyperstability of control systems Springer Grundleheren series

**ECL515 Intelligent System Design [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Be well versed with concept of intelligent system design: features, standards etc.
2. Be familiar with and able to apply various approaches of modeling of intelligent systems.
3. Be able to perform error analysis in intelligent system design.
4. Be familiar with utilizing soft computing tools for intelligent system design.
5. Develop skill of implementing real time various hardware/software platforms based intelligent systems.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | | |
| **CO2** | | 2 | 3 | | |
| **CO3** | 1 | | 2 | 2 | |
| **CO4** | 1 | | | 2 | |
| **CO5** | 2 | | 2 | | |

**Contents**

Concept of Intelligent systems, motivation and design features, Modeling of Intelligent Systems. Evolution in ISD Errors and types of errors for intelligent control, different methods of error estimation. Relevance of Artificial Intelligence in ISD. Relevance of soft computing tools in ISD: Fuzzy logic, Neural network, GA, Rough Sets, SWARM etc. Real Time ISD implementation, software and hardware tools and methodologies used. Case Studies and applications of ISD.

**Text Books**

1. Ajith Abraham, Katrin Franke, Mario Köppen, “Intelligent system Design and applications”, Springer.

**Reference Books**

1. Fakhreddine O. Karray, Clarence W. De Silva, “Soft computing and intelligent systems design: Theory, tools, and applications”, Pearson/Addison Wesley.
2. Larry Bielawski, Robert Lewand Wiley, “Intelligent systems design: Integrating expert systems, hypermedia, and database technologies”, Wiley Professional Computing.
3. Wout van Wezel (Editor), R. J. Jorna (Editor), Alexander M. Meystel (Editor) , “Planning in Intelligent Systems: Aspects, Motivations, and Methods”, Wiley.

4. Alexander M. Meystel, James S. Albus Wiley , “Intelligent Systems: Architecture, Design, and Control”, Wiley-Blackwell.
5. K. Truemper, “Design of logic-based intelligent systems”, Wiley.

**ECL527 Spectrum Management [(3-0-0); Credit: 3]**

Pre-requisites:

**Course Outcomes**

Students will

1. Be familiar with fundamental issues in spectrum management
2. Be conversant with issues in EMC
3. Be aware of functioning of organizations like ITU
4. Be knowing fundamentals of spectrum planning.
5. Be aware of spectrum monitoring techniques and their role in spectrum management.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 2 |
| **CO2** | 2 | 2 | 2 | 1 | 1 |
| **CO3** | 2 | 2 | 2 | 1 | 1 |
| **CO4** | 2 | 2 | 3 | 3 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 2 |

Fundamentals of Spectrum Management, Management of RF Spectrum and satellite Orbit, Services Fixed, mobile and Satellite, Radio determination and Radiolocation, Broadcasting etc Electromagnetic Compatibility (EMC) Studies for providing interference free environment/protection of various services Coordination efforts to ensure co-existence of various types of radiocommunication services.

Major National Spectrum Management Directives/Laws, Organizational Structure and Processes of ITU-Radiocommunication Sector (ITU-R) Spectrum Management Planning, Regulation and Policy Making, Development of a National Frequency Allocation Plan,Frequency Assignment and Licensing, Relevance of Spectrum usage charge with the Spectrum Management, Monitoring and Spectrum Enforcement, Types of Spectrum Monitoring Stations International and National Cooperationand coordination

Spectrum Planning

Significance of Planning, Costs and Benefits, Concept of Harmonization

Planning Processes, Establishing Spectrum Planning Objectives, Spectrum Availability and Usage Trends, Future Spectrum/Service Requirements Rights of spectrum usage, exclusive or market driven or collective, Planning Implementation, Short Term, Long Term, Strategic Planning Improving the Spectrum Management Planning System Frequency Assignment and Licensing

Assigning Frequencies to Radio Stations, Regulatory and Technical Aspects of the Frequency Assignment Process, Frequency Plans, Process Automation

Requirements of Licensing , Licensing Radio Stations, Deregulation of Licensing, Licensing Practices, On-Line Licensing and Security Issues

Spectrum Monitoring and Inspection

Spectrum Monitoring as an Element of the Spectrum Management Process, Monitoring to Assist Frequency Assignment, to Assess Spectrum Occupancy and for Compliance with National Rules and Regulations.

Monitoring Facilities Depending on a Frequency Band and Purpose, Automation of Monitoring, Integration of Monitoring Sub-System with Automated Spectrum Management System, Spectrum Inspection and Investigation as Elements of the Spectrum Management Process, Inspections and Investigations for Compliance with National Rules and Regulations, Verification of Technical and Operational Parameters, Detection and Identification of Unauthorized Transmissions, Inspections and Investigations to Identify the Source of, and to Resolve, Interference, Equipment for Inspections and Investigations Measures of Spectrum Utilization and Utilization Efficiency

Different Methods for Calculating optimal Spectrum Utilization, Measure of Spectrum Utilization Efficiency, Ratio of Spectrum Utilization Efficiencies/Relative Spectrum Efficiency

Whitespace and Beyond-Towards a common framework for spectrum sharing

White space overview and applications, Regulatory rules, Opportunities for the use of Space

**Books**


1. Radio Spectrum Conservation: Radio Engineering Fundamentals- by William Gosling.
2. Cognitive Radio Policy and Regulation. Editors: Medeisis, Arturas, Holland, Oliver.
3. Radio Spectrum Management: Management of the Spectrum and Regulation by David J. Withers.
4. The Radio Spectrum- by Jean- Marc Chaudc, Gerard Pogorel.
5. Essentials of Modern Spectrum Management-by Martin Cave etal.
6. Wireless Spectrum Management: Policies, Practices, and Conditioning Factors- by Amit. K. Mitra.
7. Globalization of Mobile and Wireless Communications: Today and in 2020- by Ramjee Prasad


**Reference**


1. ITU- Handbook on Spectrum Monitoring.
2. ITU Survey on Spectrum Management.
3. ITU Radio Spectrum Management Hand book.

4. Economic Aspects of Spectrum Management- Report ITU-R 2012-3.
5. ITU- Radio Regulations Articles, Edition of 2012.
6. ITU-R, “Computer-aided Techniques for Spectrum Management (CAT)”.
7. ITU-R, “Radio wave propagation information for designing terrestrial point-to-point links”.
8. ITU-R, “Digital Radio-Relay Systems”.
9. ITU-R, “Handbook on Global Trends in International Mobile Telecommunications

**CSL528 Cryptography and Information Security [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will be

1. Familiar with basic concepts and theory of cryptography.
2. Familiar with encryption and decryption algorithms used in mobile communication systems.
3. Be conversant with issues and solutions for authentication.
4. Be able to design a security system.
5. Have an idea about different security threats and counter measures.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 1 | | | |
| **CO2** | 1 | 2 | | | 2 |
| **CO3** | 1 | 2 | 2 | | 1 |
| **CO4** | | 2 | | 3 | 2 |
| **CO5** | 2 | 2 | 2 | | |

**Contents**

Introduction and Classical Ciphers, Block Ciphers and DES, Algebraic Structures: Groups, Rings, Finite and Galois Fields, AES, 2DES and 3DES, Block Modes of Operation: ECB, CBC, Basic Number Theory: Primes, Congruences, CRT, Modular Exponentiation , Asymmetric Key Cryptosystems: RSA, Elgamal, Hash and MAC: SHA-512 , Digital Signatures: RSA, Elgamal. Schnorr, DSS , Key Management: Kerberos, Diffie-Hellman, Digital Certificates, Email Security: PGP, Viruses, Worms, and other Malware , Firewalls ,

**Text books**

1. Behrouz A. Forouzan, “Cryptography and Network Security”, McGraw Hill.

**Reference books**

1. William Stallings, “Cryptography and Network Security”, PHI.
2. Bernard Menezes, Network Security and Cryptography, Cengage
3. Douglas Stinson Cryptography Theory and Practice CRC Press 1995
4. Radia Perlman Network Security: Private Communication in a Public World, Prentice Hall 2002
5. Alfred Menezes, Paul van Oorschot, Scott Vanstone Handbook of Applied Cryptography CRC Press 1997.
6. Bruce Schneier Applied Cryptography , 2nd Edition John Wiley & Sons 1996

**ECL529 Advanced Computer Architecture [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Understand high performance computing, RISC philosophy and overview of pipelined architecture.
2. Check Performance evaluation and limitations of pipelined architecture .Instruction level parallelism, superscalar architecture, dynamic pipelines, superscalar techniques,
3. Verify performance evaluation of superscalar architectures, VLIW architecture, data-level parallelism, thread-level parallelism,
4. Principles of simultaneous multi-threaded architectures, instruction fetch policies in multi-threaded architectures, multi-core architectures.
5. Design Memory and storage system.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 2 | 1 |
| **CO2** | 1 | 1 | 1 | 2 | 1 |
| **CO3** | 1 | 2 | 1 | 1 | 1 |
| **CO4** | 1 | 2 | 1 | 1 | 1 |
| **CO5** | 1 | 1 | 2 | 1 | 1 |

**Contents**

Course Introduction, Introduction to Computer Architecture, Instruction set architecture, Evolution of architectures, RISC architecture (Single cycle, multi-cycle, and pipelined architectures) , Pipeline hazards, Memory system, Cache architecture, Beyond Pipeline, Superscalar architecture, Superscalar architecture: An overview, Instruction flow optimization: Handling branches, Branch predictors – 1, Branch predictors – 2, Advanced optimization in instruction flow, register flow techniques: Register renaming and out of order execution, Out of order execution, Advanced data flow techniques: Instruction reuse and value prediction, Memory data flow, Advanced memory data flow architectures, Limits of superscalar architectures, Beyond ILP, Multi-threading, Simultaneous multithreaded (SMT) architectures, SMT architecture: Choices, SMT performance on various designs, SMT architecture: OS impact and adaptive architectures, VLIW architectures, Multiscalar architecture, Multi-core Architectures, Multicore Interconnect – NOC, Network-on-Chip, Cache

Coherence, Cache Consistency model, Dynamic Core architectures, GP-GPU Architecture ,CPU-GPU Integration

**Reference Book**


1. J.L. Hennessy, and D.A. Patterson, *Computer Architecture: A quantitative approach*, Fifth Edition, Morgan Kaufman Publication, 2012
2. J.P. Shen and M.H. Lipasti, *Modern Processor Design*, MC Graw Hill, Crowfordsville, 2005
3. Current Literature (Papers from ISCA, Micro, HPCA, ICCD, and IEEE Trans. on Computers, IEEE Architecture Letters)


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**ECL425 High Power RF Devices and Systems [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will be

1. Familiar with basic concepts and theory of RF & Microwave Engineering.
2. Be able to demonstrate working of high frequency source.
3. Be able to solve problems on microwave communication system.
4. Be able to design, implement, analyse and maintain a high frequency communication system
5. Have an idea about different microwave network circuits.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 2 | | 2 | |
| **CO2** | 3 | 2 | 2 | | |
| **CO3** | | 2 | 3 | | |
| **CO4** | | | 2 | 2 | |
| **CO5** | 1 | | 2 | 2 | |

**Contents**

Review of RF & Microwave spectrum, introduction to applications of high power RF & Microwaves Microwave Tubes: Two cavity and multi-cavity Klystron, Reflex Klystron- relation between repeller voltage and accelerating voltage, relation between repeller voltage and frequency of operation, Transit time and mode number, power frequency characteristics tuning, application.

Traveling wave tube: Study of slow wave structure, M & O type TWT, Expression for optimum value D.C biasing voltage to build up amplification in TWT, application. Magnetron: Operation of magnetron oscillator, mode jumping in magnetron, Rikie diagram and graphical representation of performance characteristics of magnetron, application. Backward wave oscillator: working principles, characteristics. Study of O type BWO. Microwave Passive components for high power systems: Directional coupler – Bathe hole coupler, double hole coupler, Moreno crossed guide coupler, multi hole coupler, Faraday rotation: Circulator, Isolator, Gyrator

Microwave hybrid circuits – Magic Tee, Rat race, Branch line coupler Waveguide Irises

Cavity Resonators – Rectangular cavity resonator, Q of a rectangular cavity resonator

Microwave Measurement: Measurement of VSWR-Low, Medium and High, Measurement of power, Bolometer, Frequency measurement, Impedance measurement, attenuation measurement Cavity Q measurement.

High power RF system: Case studies, Radar, TV transmission, Satellite Communication Systems.

**Text Books**

1. S.Y.Liao; Microwave Devices & Circuits; Pearson Education/PHI
2. Microwave Engineering 3rd Edition, David M Pozar, John Wiley and Sons, 2005

**Reference Books**

3. Foundation of Microwave Engineering, R E Collin, McGraw Hill International;
4. Microwave Devices & Circuit Design, Ganesh Prasad Srivastava & Vijay Laxmi Gupta, PHI, 2006
5. K.C.Gupta; Microwaves; New Age Publishers

**ECL514 Electromagnetic Interference and Compatibility [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Be familiar with basic concepts of EMI &EMC
2. Be able to understand different types of EMI &EMC.
3. Be able to solve problems on EMI & EMC.
4. Be able to test any electronic circuit for EMI
5. Will have idea about minimization of EMI and ensuring EMC.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 3 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 2 | 2 | 1 |
| **CO3** | 2 | 1 | 3 | 3 | 1 |
| **CO4** | 2 | 1 | 2 | 3 | 1 |
| **CO5** | 1 | 1 | 2 | 2 | 1 |

**Contents**

Aspects of EMC with examples , Common EMC units, EMC requirements for electronic systems , Radiated emissions, Conducted emissions, ESD.

Application of EMC design , Wires, PCB lands, Component leads, resistors, capacitors, inductors, ferrites. Electromechanical devices ,Digital circuit devices . Mechanical switches ( as suppression) , Noise pick-up modes and reduction techniques for analog circuits.

Use of co-axial cables and shielding of signal lines.

Simple emission models for wires and PCB lands, Line impedance stabilization network (LISN), Power supply filters. Power supplies including SMPS. EMI induced failure mechanisms for power electronic equipment.

Three conductor lines and crosstalk, Shielded wires , Twisted wires, Multi-conductor lines and effects of incident fields, Shielding, Origin effects , prevention of ESD event, its hardware and immunity. System design for EMC, Grounding, System configuration, PCB design. EMC in the design of digital circuits. ESD and switching interference reduction.

Susceptibility aspects of power electronic and digital equipment.

Shielding of electronic equipment.

EMC standards and test equipment and testing procedures and methods.

**Reference Books**

1. Noise Reduction Techniques in Electronic Systems, 2nd Edition - Ott HW
2. Electrostatic Damage in Electronics : Devices and Systems - Willium B Greason, Johan Wiley and Son'.
3. Digital Bus Hand Book - Joseph Di Giacomo, McGraw-Hill Publishing Company. 11

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**ECL530 Contemporary Embedded Systems [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Be familiar with basic concepts of Contemporary Embedded Systems.
2. Be able to understand different application of Embedded Systems.
3. Be able to solve problems on Embedded Systems.
4. Be able to design any electronic circuit in platform of Embedded system.
5. Will have idea about current research in embedded systems.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | | | 2 | 1 | 1 |
| **CO2** | 2 | | 2 | 1 | |
| **CO3** | 3 | | 3 | 3 | |
| **CO4** | 2 | | 2 | 3 | |
| **CO5** | 2 | 1 | 1 | | 2 |

**Contents**

Reading Switches Introduction, Basic techniques for reading from port pins, Example: Reading and writing bytes, Example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version), The need for pull-up resistors, Dealing with switch bounce, Example: Reading switch inputs (basic code), Example: Counting goats, Conclusions

Adding Structure to the Code Introduction, Object-oriented programming with C, The Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the 'Hello Embedded World' example, Example: Restructuring the goat-counting example, Further examples, Conclusions

Meeting Real-Time Constraints Introduction, Creating 'hardware delays' using Timer 0 and Timer 1, Example: Generating a precise 50 ms delay, Example: Creating a portable hardware delay, Why not use Timer 2?, The need for 'timeout' mechanisms, Creating loop timeouts, Example: Testing loop timeouts, Example: A more reliable switch interface, Creating hardware timeouts, Example: Testing a hardware timeout, Conclusions

**Text Books**

1. Embedded C - Michael J. Pont, 2nd Ed., Pearson Education, 2008

**Reference Books**

1. PICmicro MCU C-An introduction to programming, The Microchip PIC in CCS C - Nigel Gardner

**ECL531 Machine Learning and Learning Machines [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Have learnt the foundations and concepts of probability and statistics required for machine learning and learning machines.
2. Be familiar with the theory of machine learning
3. Be able to apply the concepts and theory of machine learning to solve problems
4. Be able to transform the concepts and theory of machine learning into design of learning machines and their architectures.
5. Be able to use simple learning machines for solving real life problems.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 2 | 2 | 2 |
| **CO3** | 3 | 1 | 2 | 2 | 2 |
| **CO4** | 3 | 1 | 3 | 2 | 2 |
| **CO5** | 3 | 1 | 2 | 1 | 3 |

Introduction Basic concepts Supervised learning. Supervised learning setup. LMS. Logistic regression. Perceptron. Exponential family. Generative learning algorithms. Gaussian discriminant analysis. Naive Bayes.

Support vector machines. Model selection and feature selection. Ensemble methods: Bagging, boosting.

Evaluating and debugging learning algorithms.

Learning theory Bias/variance tradeoff. Union and Chernoff/Hoeffding bounds. VC dimension. Worst case (online) learning. Practical advice on how to use learning algorithms. Unsupervised learning. Clustering. K-means. EM. Mixture of Gaussians. Factor analysis. PCA (Principal components analysis). ICA (Independent components analysis). Reinforcement learning and control.MDPs. Bellman equations, Value iteration and policy iteration. Linear quadratic regulation (LQR). LQG,Q-learning. Value function approximation. Policy search. Reinforce. POMDPs.

**Books**


1. Richard Duda, Peter Hart and David Stork, Pattern Classification, 2nd ed. John Wiley & Sons, 2001.
2. Tom Mitchell, Machine Learning. McGraw-Hill, 1997.
3. Richard Sutton and Andrew Barto, Reinforcement Learning: An introduction. MIT Press, 1998

4. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning. Springer, 2009

**ECL532 Wavelets and Multi-media Applications [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Have learnt, understood and consolidated theory of multi-resolution analysis and filter banks.
2. Have visualized mathematical concepts of Wavelets based analysis.
3. Be able to solve simple and real life analysis problems using computer programs of wavelets.
4. Have learnt concepts of wavelet filter synthesis for specific applications.
5. Be able to design wavelet filters for real life applications

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | | | |
| **CO2** | 3 | 2 | 2 | | |
| **CO3** | 2 | 1 | | 3 | 2 |
| **CO4** | 1 | 1 | | 3 | 2 |
| **CO5** | 1 | 1 | | 3 | 3 |

**Contents**

Signal Representation: Fourier, Cosine, Sine, Hartley, Haar, Slant, Walsh and Short-time orthogonal transforms

Image and video international compression standards: JPEG, H.261 , Subband decompositions 1-D and 2-D Wavelets: construction, properties, decomposition, and reconstruction, multiresolution and analysis, Wavelet Packets

Multimedia Signal Processing (multimedia signal enhancement, de-noising, compression), Multimedia Security (Watermarking and Steganography)

**Books**

1. Chun-Shien Lu, Multimedia Security: Steganography and Digital Watermarking Techniques for Protection of Intellectual Property, Idea Group Publishing, ISBN: 1591401925
2. Metin Akay, Time Frequency and Wavelets in Biomedical Signal Processing, Wiley-IEEE Press, ISBN: 0780311477

**ECL512 Topics in Communication Systems [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

After completing this course the student will demonstrate the knowledge and ability to:

1. Apply the fundamentals of communication engineering to understand the advanced topics.
2. Understand the need and evolution of advanced communication systems.
3. Learn various tools required for the analysis and design of the upcoming communication systems.
4. Evaluate the performance of contemporary communication systems and relate it to the quality of service.
5. Utilize their basic knowledge for optimizing the cross-layer parameters to design an end-to-end system.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 3 | 2 |
| **CO2** | 1 | 2 | 2 | 3 | 3 |
| **CO3** | 2 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 3 |

**Contents**

The course will contain the advance topics related to (but not limited to) one or more than one areas of communication engineering

- Communication Engineering
- Wireless Communication
- Satellite Communication
- Optical Communication
- Signal processing for communication
- RF circuits design
- Computer Communication
- Information Theory
- Multimedia Communication

**Text Books**

1. Theodore S Rappaport: "Wireless Communications, Principles and Practice", Second Edition Pearson Education Asia.
2. K J Ray Liu et al, Cooperative Communication
3. Simon, Alouni, "Digital Communication over Fading Channels" John Wiley & Sons, 2005.
3. Andrea Goldsmith, "Wireless Communication", Wiley Publishers. 2005.

**Reference Books**

1. William Stallings. "Wireless Communications and Networks, Pearson Education Asia.
2. 3G Mobile Networks by Sumit Kasera McGraw Hills publication. 2007.
3. Simon Haykin and Michael Moher, " Modern Wireless Communications", Person Education.

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**Note:** Text and reference books are to be announced by the course coordinator every time the course is being conducted.

**MAL503 Optimization Techniques [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Be able to apply linear programming and simplex methods to engineering problems
2. Be conversant with various searching algorithms
3. Be applying concepts of constrained optimization
4. Be conversant with successive linear programming
5. Be conversant with successive quadratic programming.

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | | |
| **CO2** | 2 | 2 | 3 | | |
| **CO3** | 3 | | 1 | | 2 |
| **CO4** | | | | | |
| **CO5** | | | | | |

**Contents**

Motivation. mathematical review , matrix factorizations, sets and sequences, convex sets and functions, linear programming and simplex method, Weierstrass' theorem, Karush Kuhn Tucker optimality conditions, algorithms, convergence, unconstrained optimization, Line search methods, method of multidimensional search, steepest descent methods, Newton's method, modifications to Newton's method , trust region methods, conjugate gradient methods, quasi-Newton's methods. constrained optimization, penalty and barrier function methods, augmented Lagrangian methods, polynomial time algorithm for linear programming, successive linear programming, successive quadratic programming.

**Text Books**


1. J.C. Pant : Introduction to Optimisation: Operations Research, Jain Brothers, New Delhi, 2004.
2. S.S. Rao: Engineering Optimization : Theory & Practice, New Age International (p) Limited, 1998.


**Reference Books**


1. H.M.Wagner : Principles of Operations Research, Prentice Hall of India, New Delhi, 1982.
2. David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, 3rd Edition,Springer, 2008.
3. Fletcher R., Practical Methods of Optimization, John Wiley, 2000.
4. Venkataraman P., Applied Optimization with MATLAB Programming, Wiley, 2001

**MAL504 Linear Algebra and Applications [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Be able to apply matrix algebra for finding solutions to equations
2. Be able to find inverse of non-singular matrix
3. Be applying concepts of linear operators.
4. Be able to apply concepts of orthonormal sets to vector spaces
5. Be able to apply various optimization techniques to engineering problems

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | 1 |
| **CO2** | 2 | 3 | | | 1 |
| **CO3** | | | 2 | 2 | |
| **CO4** | | 1 | * | 1 | |
| **CO5** | 1 | | 1 | | 1 |

**Contents**

Matrices: Review of Matrix Algebra; Rank of matrix; Row reduced Echelon form, Determinants and their properties, Solution of the matrix Equation Ax = b, Gauss elimination method; Vector Space, Subspaces, Linear Dependence/Independence, Basis, Dimension, Linear transformation, Range Space and Rank, Null Space and Nullity, Rank nullity theorem, Matrix Representation of a linear transformation, Linear Operators on Rn and their representation as square matrices, Invertible linear operators, Inverse of a non-singular matrix.

Eigen values and eigenvectors of a linear operator, properties of eigenvalues and eigenvectors of Hermitian, skew-Hermitian, Unitary, and Normal matrices (including symmetric, skew-symmetric, and orthogonal matrices), Characteristic Equation, Bounds on eigenvalues, Cayley Hamilton theorem, Diagonalizability of a linear operator.

Inner Product Spaces, Norm, Orthonormal Sets, Gram Schmidt orthogonalisation process, projections and least squares approximation.

Optimization: Modeling and formulation of optimization problems, Least cost and Convex domain, Linear programming and Simplex Algorithm (Big M and Two Phase Method), Duality and the primal dual method.

**Text Books**

1. Hoffman and Kunze : Linear Algebra, Prentice Hall of India, New Delhi
2. Gilbert Strang : Linear Algebra And Its Applications (Paperback) , Nelson Engineering (2007)

**Reference Books**

1. V. Krishnamoorthy et al : An introduction to linear algebra , Affiliated East West Press, New Delhi
2. P.G. Bhattacharya, S.K. Jain and S.R. Nagpaul : First course in Linear Algebra, Wiley Eastern Ltd., New Delhi
3. K.B.Datta : Matrix and Linear Algebra, Prentice Hall of India, New Delhi

**CSL517 : Pattern Recognition [(3-0-0); Credit: 3]**

**Pre-requisites:**

**Course Outcomes**

Students will

1. Be familiar with applications of pattern recognition
2. Be conversant with parameter estimation approaches
3. Be able to distinguish between various types of classifiers
4. Be able to apply concepts of artificial neural networks to classification problem
5. Be able to apply various pattern recognition methods to image processing

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 1 | 1 |
| **CO2** | 3 | 1 | 3 | 1 | 1 |
| **CO3** | 3 | 1 | 2 | 2 | 2 |
| **CO4** | 3 | 1 | 2 | 2 | 3 |
| **CO5** | 3 | 1 | 1 | 2 | 3 |

**Contents**

Applications of pattern recognition, statistical decision theory, probability of events, Random variables, Estimation of parameters, Minimum Risk Estimators, Baye's Theorem, conditionally independent features. Decision boundries, Estimation of error rates, characteristics curves, Histograms, Kernel and window parameters, Nearest Neighbour classification techniques, Adaptive Decision boundries, clustering, Artificial Neural Networks, Nets without hidden layers and with hidden layers. The back propagation Algorithm, Hopfield Nets, Gray level scaling transformations, Equalization smoothing transformations. Edge detection Logarithmic Gray scale level scaling. Scene segmentation and labelling , counting objects, Hough Transforms, Eigenvector line fitting , Fourier transforms.

**Text / References**


1. Pattern Classification : Richard O.Duda, Peter E.Hart, David G.Shork, John Wiley & Sons 200, 2nd Edittion
2. Pattern Recognition and Image Analysis , Earl Gose, Richard Johnsonbough , Steve Jost . Prentice Hall of India
3. Pattern Recognition and Image Processing : Sing Tze bow; Marcel Dekker

**ECL528 Detection and Estimation in Wireless Systems [(3-0-0); Credit: 3]**
**Pre-requisites:**

**Course outcomes**

Students will

6. decompose a signal in terms of its basis functions.
7. to evaluate the error performance of the various modulation techniques.
8. state maximum likelihood, maximum a posteriori probability, and least-squares estimation problems;
9. find the maximum likelihood, maximum a posteriori probability and least-squares estimates of a parameter;
10. evaluate performance of decision making and estimation systems;

| | PO1 | PO2 | PO3 | P04 | PO5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 2 | 2 |

**Contents**

Introduction, binary hypothesis test: decision criterion, performance, receiver operating characteristics. M-Hypotheses.

Estimation theory: random parameters, Baye's estimation, likelihood ratio test, real parameter estimation, multiple parameter estimation. Detection and estimation in white Gaussian noise, detection of signals in additive white Gaussian noise, linear estimation, nonlinear estimation, known signals in white Gaussian noise, detection and Estimation in Non-white Gaussian Noise, whitening approach.

**Text Books**


1. H. L. Van Trees, K. L. Bell , Z. Tian, "Detection Estimation and Modulation Theory (I)" 2E, Wiley.
2. U. Madhow, "Fundamentals of Digital Communication", Cambridge University Press, 2008.
3. J. G. Proakis, "Digital Communications", 4E, McGraw Hill, 2000.

**Reference Books**


4. S. Benedetto and E. Biglieri, “Principles of Digital Transmission with Wireless Applications”, Kluwer Academic, 1999.
5. R. G. Gallager, “Principles of Digital Communication”, Cambridge University Press, 2008.