Master of Technology

in

Communication and Information Systems

Regulations, Curriculum and Syllabus

(With Effect from 2019-2020)

Department of Electronics Engineering

School of Engineering and Technology

Pondicherry University

Puducherry - 605 014

INDIA

i) CBCS Regulations for M.Tech. (Communication and Information Systems)

The Department of Electronics Engineering under the School of Engineering and Technology, Pondicherry University, Pondicherry was started in the academic year 2010 – 2011 with Master of Technology (M.Tech) programme in Electronics.

Besides the Choice Based Credit System (CBCS) regulations specified by Pondicherry University in respect of engineering post graduate degree admission, evaluation and awarding degree, the following norms are applicable for this programme.

Name of the Programme	M.Tech. (Communication and Information Systems)
Nature of Programme	Regular, Coming under Engineering Department.
Programme Duration	Two years (Four Semesters). However, one can complete the programme within maximum of eight semesters.
Eligibility Criteria	In addition to University regulations in respect of passing marks at undergraduate level and other criteria, candidates who are holding any one of the following degrees alone shall be considered for this M.Tech Programme: B.E / B.Tech in Electronics/ Electronics and Communication Engineering/ Electronics and Telecommunication Engineering/ Information Technology with a minimum of 55% of marks.
Admission Criteria	Based on Pondicherry University's All India Entrance Examination.
Intake	21 Students per year
Teaching and Learning Methods	Lectures, tutorials and seminars are the main methods of course delivery, which would be supplemented by individual practical work, project work, simulation assignment, seminars and industrial visits.
Minimum number of credits to be acquired for successful completion of the programme	72 Credits

Assessment Methods : CBCS is the method of assessment with the following weightage of marks for the various courses of the programme.

For Theory Courses: 40% of marks for internal and 60% for end semester examinations.

The end semester question paper will have Part A (6 × 2 = 12 Marks) consisting of six two mark questions and Part B (4 × 12 = 48 Marks) consisting of six twelve mark descriptive questions of which one of them is compulsory and totally a candidate has to answer four out of six. For the end semester examination (University Semester Examination), the questions will be chosen only from the first four units of every theory subject of the programme to account end semester marks of 60 and internally (cumulatively) to assess a candidate's depth of knowledge in the concerned subject for 40 marks, a minimum of two internal tests (30 marks) shall be conducted. Further, the content of the fifth unit in each subject shall be considered to conduct seminars, tutorials, simulations, assignments, development of hardware models etc. for 10 marks as it is formulated at system level for all subjects of the programme. The question paper setter will be appointed by the Competent Authority of the University. However, the evaluation shall be carried out by both internal and external examiners.

For Practical Courses: 75% of marks for internal and 25 % for end semester examinations.

NPTEL/MOOC/GIAN Course:

It is mandatory to undergo one course related to the chosen programme for the minimum period of 30 hours either from NPTEL or GIAN or MOOC that is to be completed at any period of the duration of M.Tech. programme to fulfill the partial requirements for the award of M.Tech. degree. Absolute grade shall be awarded to a candidate based on the marks given in the certificate issued by the competent authority (NPTEL or GIAN or MOOC) for the chosen course.

Project - Literature Survey: 100% of marks through internal assessment only.

It is mandatory to undergo a complete literature survey by a candidate on the area of project work in the third semester regularly. There will be two reviews for the candidate on the literature survey carried out. There shall not be any end semester evaluation. However, the internal evaluation is based on the presentation of the candidate with the submission of a report about the literature survey. It will be done by the committee comprising of internal members and one external member from other department of the same institute constituted by Head of the Department for the award of appropriate grade to the candidate based on the performance. The distribution of marks for the literature survey will be decided by the committee.

For Project and Viva Voce: 75% of marks for internal and 25% for end semester examinations.

The Project work shall be evaluated for a maximum of 100 marks. There shall be three assessments during the fourth semester by a review committee. The Head of the Department shall constitute the review committee consisting of supervisor, project coordinator and another faculty member from the Department for the internal assessment (50 marks). The contribution by the respective supervisor of a student for 25 marks shall be accounted for the internal marks of 75. The end semester Project Viva Voce (for 25 marks) shall be conducted by the external member nominated by the competent Authority of the University. The distribution of the marks is shown in the Table given below.

Allocation of Marks for Project and Viva Voce (100 Marks)					
Internal (75 Marks)				**External (25 Marks)**	**Total (100 Marks)**
Review Committee (50 Marks)			Supervisor (25 Marks)		
First Review	Second Review	Third Review			
10 Marks	20 Marks	20 Marks	25 Marks	25 Marks	100 Marks

Publication: Mandatory requirement for the completion of the programme.

It is mandatory to have a minimum of one submitted manuscript / accepted publication in reputed journal (SCI/Scopus/Web of Sciences) during the M.Tech. programme. However, the submitted manuscript / accepted paper is subject to the recommendation of the evaluating committee comprising of internal members from same Department constituted by Head of the Department and one external member (examiner) from other institute nominated by competent Authority of University for the acceptance of the quality of the manuscript /paper of the candidate. The publication can be made at any period of the duration of M.Tech. programme. However, it does not contribute any credits to the programme but mandatory to fulfill the partial requirements for the award of M.Tech. degree. This evaluation process may be carried out along with one of the even end semester examinations depending up on the status of the students.

Non Compliance:

Non complaining the requirements of any course(s) by a candidate at any period of the duration of programme shall lead to warrant the implementation of prevailing University CBCS regulations.

ii) Curriculum for M.Tech. (Communication and Information Systems)

I Semester

Sl. No	Course Code	Name of the Course	H/S	L-T-P	Credits
1	ECIS 510	Communication Systems Laboratory	H	0-0-4	2
2	ECIS 511	Advanced Digital Communication	H	3-1-0	4
3	ECIS 512	Communication Networks	H	3-1-0	4
4	ECIS 513	Error Correcting Codes	H	3-1-0	4
5	ECIS 514	Probability and Random Process	H	3-1-0	4
6		Elective I	S	2-1-0	3
7		Elective II	S	2-1-0	3
Total Credits for Semester I					**24**

(H – Hard Core Course; S – Soft Core Course)

II Semester

Sl. No	Course Code	Name of the Course	H/S	L-T-P	Credits
8	ECIS 520	Information Systems Laboratory	H	0-0-4	2
9	ECIS 521	Adaptive Signal Processing	H	3-1-0	4
10	ECIS 522	Advanced Computer Architecture	H	3-1-0	4
11	ECIS 523	Advanced Wireless Communication	H	3-1-0	4
12	ECIS 524	Information and Network Security	H	3-1-0	4
13		Elective III	S	2-1-0	3
14		Elective IV	S	2-1-0	3
Total Credits for Semester II					**24**

(H – Hard Core Course; S – Soft Core Course)

III Semester

Sl. No	Course Code	Name of the Course	H/S	L-T-P	Credits
15		Elective V	S	2-1-0	3
16		Elective VI	S	2-1-0	3
17		Elective VII	S	2-1-0	3
18	ECIS 611	NPTEL/MOOC/GIAN course	H	0-2-0	2
19	ECIS 612	Project - Literature Survey	H	0-0-1	1
Total Credits for Semester III					**12**

(H – Hard Core Course; S – Soft Core Course)

IV Semester

Sl. No	Course Code	Name of the Course	H/S	L-T-P	Credits
20	ECIS 620	Project and Viva Voce	H	0-0-12	12
21	ECIS 621	Publication	-	-	0
Total Credits for Semester IV					**12**

(H – Hard Core Course; S – Soft Core Course)

Total number of credits required to complete
M.Tech (Communication and Information Systems) : 72 Credits

Semester I – List of Electives

Sl. No	Course Code	Name of the Course	L-T-P	Credits
1	ECIS 530	Advanced Electromagnetics	2-1-0	3
2	ECIS 531	Database Design	2-1-0	3
3	ECIS 532	Data Mining and Data Warehousing	2-1-0	3
4	ECIS 533	Embedded System Design and Architecture	2-1-0	3
5	ECIS 534	Image Processing Techniques	2-1-0	3
6	ECIS 535	Optical Communication	2-1-0	3
7	ECIS 536	Satellite Communication	2-1-0	3
8	ECIS 537	Software Architecture and Interoperability	2-1-0	3

Semester II - List of Electives

Sl. No	Course Code	Name of the Course	L-T-P	Credits
1	ECIS 550	Advanced Technologies in Wireless Networks	2-1-0	3
2	ECIS 551	Management Information Systems	2-1-0	3
3	ECIS 552	Modeling and Simulation of Communication Systems	2-1-0	3
4	ECIS 553	Multimedia systems	2-1-0	3
5	ECIS 554	Network Administrative Systems	2-1-0	3
6	ECIS 555	Pattern Recognition and Artificial Intelligence	2-1-0	3
7	ECIS 556	Radiation Systems	2-1-0	3
8	ECIS 557	Speech and Audio Processing	2-1-0	3

Semester III - List of Electives

Sl. No	Course Code	Name of the Course	L-T-P	Credits
1	ECIS 630	Advanced Distributed Systems	2-1-0	3
2	ECIS 631	Big Data Analytics	2-1-0	3
3	ECIS 632	Cloud Storage and Computing	2-1-0	3
4	ECIS 633	Cognitive Radio	2-1-0	3
5	ECIS 634	Convergence Technologies	2-1-0	3
6	ECIS 635	Cooperative Communication Systems	2-1-0	3
7	ECIS 636	Free space Optical Networks	2-1-0	3
8	ECIS 637	Green Radio Communication Networks	2-1-0	3
9	ECIS 638	Internet of Every Thing (IoET)	2-1-0	3
10	ECIS 639	Low Power Digital VLSI Design	2-1-0	3
11	ECIS 640	Real Time Operating System	2-1-0	3
12	ECIS 641	Sensors and Actuators	2-1-0	3
13	ECIS 642	Soft Computing	2-1-0	3
14	ECIS 643	Vehicular Ad-hoc Networks (VANET)	2-1-0	3

iii) Syllabus for M.Tech. (Communication and Information Systems)

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 510	COMMUNICATION SYSTEMS LABORATORY	0	0	4	2	60

OBJECTIVE: Hands-on experience on hardware and software experiments in order to acquire sufficient knowledge and understand the practical nuances of various communication techniques.

OUTCOME: Students will be able to design, implement/ simulate various functional modules of a communication system.

LIST OF EXPERIMENTS (Given the list is minimal, however, the course teacher can decide the level of experiments)

SOFTWARE:

1. Modulation in AWGN/ Wireless communication channel
2. Observation (simulation) of signal constellations of BPSK, QPSK and QAM
3. Error control / Line coding schemes
4. QMF
5. Wireless channel equalizer (ZF/LMS/RLS)
6. OFDM transceiver system
7. MIMO system (STBC/STTC)

HARDWARE:

8. Spectral analysis of modulation signals using spectrum analyzer
9. S Parameters characterization of antennas using network analyzer
10. Performance evaluation of digital data transmission techniques through optical fiber link
11. GMSK modulation
12. Study of CDMA system
13. Study of GPS system
14. Study of MIMO-OFDM system
15. Study of SDR.

ECIS 510

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 511	ADVANCED DIGITAL COMMUNICATION	3	1	0	4	60

Prerequisite: Basics of analog and digital communication systems.

Objective : To make the students to understand the various advanced concepts of digital communication techniques.

Outcome : Students will be able to imply the concepts of advanced digital communication techniques to various applications.

Unit I: Digital Modulation Techniques **12 Hours**

Elements of digital communication system - factors influencing digital modulation techniques; Linear modulation techniques: BPSK - QPSK - DPSK; Constant envelope modulation techniques: MSK- GMSK; Linear and constant envelope modulation techniques: M- ary PSK and M- ary QAM.

Unit II: Additive White Gaussian Noise Channel **12 Hours**

Optimum receiver for signals corrupted by AWGN - performance of the optimum receiver for memory less modulation; Optimum receiver for CPM signals - optimum receiver for signals with random phase in AWGN channel.

Unit III: Equalization Techniques **12 Hours**

Optimum receiver for channels with ISI and AWGN – Nyquist criterion for zero ISI - linear equalization and its variations - decision feedback equalization - predictive decision feedback equalization - turbo equalization.

Unit IV: Synchronization **12 Hours**

Signal parameter estimation: Carrier phase estimation - symbol timing estimation - joint estimation of carrier phase and symbol timing - performance characteristics of ML estimators.

Unit V: Activities Based Learning **12 Hours**

Simulation: Different digital modulations - AWGN channel - equalization techniques and synchronization using any related platforms.

Reference Books:

1. George R. C and Clare D M, "Modern Communications and Spread Spectrum", McGraw Hill, 1986.
2. John G P and Masoud S, "Digital Communications", 5th Edition, McGraw Hill, 2014.
3. Kamilo Feher, "Wireless Digital Communications Modulation and Spread Spectrum Applications", Prentice Hall India, 1995.
4. Bernard S, "Digital Communication fundamentals and applications", 2nd Edition, Pearson education, 2009.
5. Theodire S R, "Wireless Communications", 2nd Edition, Pearson Education, 2010.

Hyperlinks:

1. http://nptel.iitm.ac.in/courses/117101051.html
2. http://nptel.ac.in

ECIS 511

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 512	COMMUNICATION NETWORKS	3	1	0	4	60

Prerequisite: Computer Networks, Wireless and Optical Communication

Objective : To understand the architecture and standards of wireless & optical networks.

Outcome : Students will be able to design state-of-the-art communication networks for real time scenario.

Unit I: Introduction to Networks **12 Hours**

Background: Telephone networks - data communication networks - standards - ISO reference model; data transmission - asynchronous and synchronous transmission - transmission control circuits and devices; Evolution of public mobile services - motivations for IP based services, Wireless IP network architecture - 3GPP packet data network architecture.

Unit II: Wireless Networks **12 Hours**

Wireless Networks - need - design issues and challenges; Access technologies: DSL standards - hybrid fiber coax - cable modem – WLAN / IEEE 802.11 - architecture and services - access methods - WiMAX/802.16 - architecture and services - LTE/LTE-A architecture and specifications - design issues and challenges of 5G networks.

Unit III: Optical Networks **12 Hours**

Optical Networks: SONET / SDH - WDM networks - FTTX – Metropolitan area networks; Broadcast and select networks - topologies for broadcast networks - testbeds for broadcast and select networks; Wavelength routing architecture and testbeds; WOBAN and OTDM networks.

Unit IV: Inter Networking between WLANS and 3GWANs **12 Hours**

Internetworking - objectives and requirements - schemes to connect WLANs and 3G networks - session mobility - internetworking architecture for WLAN and GPRS, LMDS, MMDS- Internetworking of WiMAX and LTE

Unit V: Activities Based Learning **12 Hours**

Simulation of minimum (3) wireless communication networks scenario using related simulation tool.

Reference Books:

1. Kaveh Pahlavan and Prashant Krishnamurthy, "Principle of Wireless network - A Unified Approach", Prentice Hall, 2006.
2. Rajiv Ramaswami, Kumar N. Sivarajan, "Optical Networks: A Practical Perspective", 2nd Edition, Harcourt Asia Pvt Ltd., 2004.
3. C. Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Networks: Concept, Design and Algorithms", 1st Edition, Prentice Hall India, 2002.
4. Moray Rumney, "LTE and the Evolution to 4G Wireless Design and Measurement Challenges", Agilent Technologies, 2009.
5. Thomas Plavyk, "Next generation Telecommunication Networks, Services and Management", Wiley and IEEE Press Publications, 2002.
6. Sumit Kasera and Nishit Narang, "Communication Networks: Principles and Practice", McGraw Hill Education Private Limited, 2005

Hyperlinks:

1. https://freebookee.com/pdf/pr/principle-of-wireless-networks-by-kaveh-pahlavan.html
2. http://www.cesarkallas.net/arquivos/faculdade-pos/TP319-redes-opticas/Optical-Networks-3nd.pdf
3. https://books.google.co.in/books/about/LTE_and_the_Evolution_to_4G_Wireless.html?id=PG0DDQAAQBAJ&redir_esc=y

ECIS 512

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 513	ERROR CORRECTING CODES	3	1	0	4	60

Prerequisite : Digital Logic Design and Circuits

Objective : To make the students to understand the concepts of various error detecting and correcting codes.

Outcome : Students will able to design an error detecting and correcting codes for real time communication system.

Unit I: Introduction **12 Hours**

Coding: Basic definitions - block codes - maximum likelihood decoding - decoding tables - hamming weight and distance - error correction vs detection.

Unit II: Linear Block Codes **12 Hours**

Definition - generator matrix - parity check matrix - error detection and correction capability of a linear code - standard array.

Unit III: Binary Cyclic Codes and Convolutional Codes **12 Hours**

Cyclic codes: Description of Cyclic Codes - encoding with (n-k) stage shift register - syndrome calculations and error detection - a general decoder for cyclic codes - shortened cyclic codes.
Convolutional codes: Structure of convolutional codes – decoding of convolutional codes – distance properties – punctured convolutional codes - maximum a posteriori decoding of convolutional codes - the BCJR algorithm.

Unit IV: Error Trapping Decoding for Cyclic Codes **12 Hours**

Error trapping decoding - Hamming codes - double-error-detecting and single-error-correcting Hamming Codes - a modified error - trapping decoding - Goley code; BCH Codes: Decoding of the BCH Codes - implementation of error correction – non binary BCH Codes and Reed-Solomon codes.

Unit V: Activities Based Learning **12 Hours**

Simulation of minimum of (3) error correcting/ detecting codes using related simulation tools.

Reference Books:

1. Lin and Costello, "Error Control Coding", 2nd Edition, Pearson Prentice Hall, 2004.
2. Schlegel and Perez, "Trellis and Turbo Coding", IEEE Press, 2004.
3. MacKay, "Information Theory, Inference, and Learning Algorithms", Cambridge University Press, 2003.
4. Wilson, "Digital Modulation and Coding", Pearson Prentice Hall, 1996.
5. Wicker, "Error Control Systems for Digital Communication and Storage", Prentice Hall, 1995.

Hyperlinks:

1. https://pg024ec.files.wordpress.com/2013/09/error-control-coding-by-shu-lin.pdf
2. http://onlinelibrary.wiley.com/doi/10.1002/0471667846.fmatter/pdf
3. http://www.inference.org.uk/itprnn/book.pdf

ECIS 513

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 514	PROBABILITY AND RANDOM PROCESS	L	T	P	4	60
		3	1	0		

Prerequisite : Knowledge in Set theory and Communication systems.

Objective : To make the students to understand various random processes and its conditions, and also the concepts of information theory

Outcome : Students will be able to analyze the probability related concepts and its applications.

Unit I: Introduction **12 Hours**

Sample space - events - joint and conditional probability – Baye's theorem; Definition of a random variable - Expected value of a random variable; Central moments- variance - skew; Continuous random variable, non-monotonic transformations of continuous random variable; Probability density function - cumulative distribution function - probability mass function.

Unit II: Random Processes **12 Hours**

Random process concept - first order stationary processes - second order and wide sense stationarity - nth order and strict sense stationarity - time averages and ergodicity; Autocorrelation function and its properties - cross correlation function and its properties; Gaussian random processes - Poisson random process; Entropy: joint and conditional entropy - relative entropy and mutual information - maximum entropy distributions - inequalities in information theory.

Unit III: Linear Algebra **12 Hours**

Vector Spaces: Linear vector space - linear independence - basis and dimension - linear transformation - matrix representation - diagonalizable matrices - inner product of vectors - Euclidian - frobenius and generalized p-norm of vectors and matrices - orthogonal and orthonormal vectors and matrices - Gram-Schmidt orthogonalization procedure - unitary matrices - diagonally dominant matrix - permutation matrix - Hermitian and skew - Hermitian matrices - symmetric and skew-symmetric matrices - positive definite matrices - properties of special matrices - quadratic forms - reduction of quadratic form to canonical form by orthogonalization method - condition number of a matrix - singular value decomposition.

Unit IV: Markov Processes **12 Hours**

Markov process - classification of states - classification of chains - Poisson process - transition matrix - examples of Markov chains - two state discrete time Markov chain - continuous time chains - two state continuous Markov chains - mean absorption time and probabilities.

Unit V: Activities Based Learning **12 Hours**

Simulation of entropy, random and Markov process for real time applications using suitable software packages.

Reference Books:

1. Paboulis A and Unnikrishna S P, "Probability, Random Variables and Stochastic Processes", 4th Edition, Tata McGraw Hill, 2002.
2. Peebles Z P, "Probability, Random Variables, and Random Signal Principles", 4th Edition, Tata Mc Graw Hill, 2000.
3. Michel K O, "Applied Probability and Stochastic Processes in Engineering and Physical Sciences", Wiley, 1990.
4. Kishor S T, "Probability and Statistics with Reliability Queuing and Computer Science Application", 2nd edition, Wiley, 2008.
5. Geoffrey G and Stirzaker D, "Probability and Random Processes", 3rd Edition, Oxford University press, 2004.
6. Suhov Y and Kelbert M, "Markov Chains: A Primer in Random Processes and their Applications", 2nd Edition, Cambridge University press, 2008.
7. Cover T M and Joy A T, "Elements of Information Theory", 2nd Edition, Wiley, 2012.

Hyperlinks:

1. https://brilliant.org/wiki/entropy-information-theory/
2. http://tinyheero.github.io/2016/03/20/basic-prob.html
3. http://nptel.ac.in/courses/106106097/pdf/Lecture14_RandProcess2.pdf

ECIS 514

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 520	INFORMATION SYSTEMS LABORATORY	L	T	P	2	60
		0	0	4		

OBJECTIVE:

Hands-on experience on software experiments in order to acquire sufficient knowledge and understand practical nuances of various information systems techniques.

LIST OF EXPERIMENTS (Given the list is minimal, however, the course teacher can decide the level of experiments)

1. Simulation using any open source tools
    a. Determination of various entropies and mutual information for various channels
    b. Generate and evaluate variable length source coding using a) Shannon – Fano coding and decoding b) Huffman coding and decoding
    c. K-means clustering algorithm
    d. Bayes classification

2. Simulation using any open source tools
    a. Performance evaluation of different queues, effect of queues and buffers in wired network environment
    b. Performance analysis of Ethernet LAN using N nodes
    c. Throughput analysis of wireless network consisting of TCP and UDP traffic
    d. Throughput and delay analysis of different wireless routing protocols (AODV/DSR/DSDV)
    e. Creation and analysis of Mobile IP scenario

3. Simulation using C/C++
    a. Data sorting methods to arrange a list of integers in ascending order:
        i) Insertion sort
        ii) Merge sort.
    b. i) Create a binary search tree of characters.
        ii) Traverse the above Binary search tree recursively in post order.
    c. Leaky bucket algorithm for congestion control
    d. Dijkstra's algorithm to compute the shortest path through a graph.
    e. Data link layer framing method - bit stuffing.

4. Simulation using any operating systems
    a. Communication commands (mail, write, talk)
    b. Process related commands (ps, nohup, archiving)
    c. Shell programming commands (shell variables, read, while)
    d. Setting up servers (DHCP, DNS, NFS)
    e. System administration (Booting, init, runlevel)

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 521	ADAPTIVE SIGNAL PROCESSING	3	1	0	4	60

Prerequisite : Knowledge in Signal and Systems and Digital Signal Processing

Objective : To make the students to understand the concepts in advanced signal processing mechanisms and filtering techniques.

Outcome : Students will be able to analyze and implement adaptive signal processing techniques for various applications.

Unit I: Fundamentals of Adaptive Signal Processing **12 Hours**

Introduction: Linear optimum filters - adaptive filters - linear filter structures - approaches to the development of linear adaptive filters - adaptive beam forming - four classes of applications - correlation matrix - properties of correlation matrix.

Unit II: Linear Prediction **12 Hours**

Linear optimum filtering - statement of the problem - principle of orthogonality - minimum mean square error filtering - minimum variance beamforming- Wiener filter - HOPF equations - error performance surface - forward linear prediction - backward linear prediction - Levinson Durbin algorithm – properties; Kalman filter and its characteristics.

Unit III: Steepest Descent and LMS **12 Hours**

Method of Steepest Descent: Basic idea - steepest descent algorithm applied to Wiener filters- stability - limitations.

LMS algorithm: Overview - LMS adaptation algorithms - stability and performance analysis of LMS Algorithms - LMS gradient and stochastic algorithms - convergence of LMS algorithm.

Unit IV: Recursive least squares adaptive filters **12 Hours**

Matrix inversion - lemma - exponentially weighted recursive least squares algorithm - recursion for updating the sum of weighted error squares - convergence.

Unit V: Activities Based Learning **12 Hours**

Simulation of adaptive channel equalizers - adaptive noise canceling - adaptive echo cancellers using related software packages.

Reference Books:

1. Haykin S, "Adaptive filter Theory", 5th Edition, Person Education, 2014.
2. Bernard W and Samuel D S, "Adaptive signal processing", Pearson Education, 1985.
3. Sophocles J , "Optimum signal processing-An introduction", 2nd Edition, McGraw Hill, 2007
4. Thomas S and Alexander, "Adaptive signal processing-Theory and applications", Springer - Verlag, 1986.

Hyperlinks:

1. https://www.sparkfun.com/news/2208
2. https://www.allaboutcircuits.com/technical-articles/an-introduction-to-adaptive-echo-cancellers/
3. http://zone.ni.com/reference/en-XX/help/372357A-01/lvaftconcepts/aft_ace/

ECIS 521

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 522	ADVANCED COMPUTER ARCHITECTURE	3	1	0	4	60

Prerequisite : Basic knowledge on computer organization.

Objective : The students will acquire the knowledge about technical competence in computer architecture and high-performance computing.

Outcome : Students will be able to describe the performance enhancements such as pipelining and parallelism, multi-core architectures.

Unit I: Fundamentals of Computer Design **12 Hours**

Overview of fundamentals of CPU - memory and I/O - computer performance evaluation, quantitative principles of computer architecture - instruction set architecture; RISC and CISC.

Unit II: Parallelism Overview **12 Hours**

Instruction level parallelism: ILP concepts - compiler techniques for exposing ILP - dynamic branch prediction - dynamic scheduling - multiple instruction issue - hardware based speculation - static scheduling - multi-threading - limitations of ILP; Data Level Parallelism: Vector architecture - SIMD extensions - graphics processing units; Thread level parallelism: Symmetric and distributed shared memory architectures - performance issues - synchronization - models of memory consistency.

Unit III: Pipelining Concepts **12 Hours**

Introduction – types - advanced pipelining - integer pipeline of RISC - pipeline hazards - hazard resolving - pipelining of complex instructions – multi-cycle instructions - design issues of pipeline architecture - superscalar and super pipelined processors.

Unit IV: Multi-Processor **12 Hours**

Introduction - characteristics - memory organization for multi-processor systems - synchronization and models of memory consistency - issues of deadlock and scheduling in multiprocessor systems - cache in multiprocessor systems - parallelism algorithm and pipelining techniques for multiprocessor systems.

Unit V: Activities Based Learning **12 Hours**

Case studies: Software and hardware multithreading - SMT and CMP architectures - Intel multi-core architecture - SUN CMP architecture - heterogeneous - multi-core processors - IBM cell processor.

Reference Books:

1. John L H and David A P, "Computer Architecture A Quantitative Approach", 5th Edition, Elsevier, 2012.
2. Kai H and Faye B, "Computer Architecture and Parallel Processing", Mc Graw-Hill Education, 2017.
3. Sima D, Fountain T and Kacsuk P, "Advanced Computer Architectures: A Design Space Approach", Pearson Education India, 2002.
4. David E C and Singh J P, "Parallel computing architecture: A hardware/software approach", Elsevier Publishers, 1999.
5. Kai H and Zhi.Wei Xu, "Scalable Parallel Computing", Tata McGraw Hill, 2003.

Hyperlinks:

1. http://cs.baylor.edu/~maurer/aida/courses/archintro.pdf
2. https://lecturenotes.in/subject/110/advanced-computer-architecture-aca
3. http://164.100.133.129:81/econtent/Uploads/Advanced_Computer_Architecture.pdf
4. http://www.serc.iisc.ernet.in/~viren/Courses/ACA/ACA.htm

ECIS 522

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 523	ADVANCED WIRELESS COMMUNICATIONS	L	T	P	4	60
		3	1	0		

Prerequisite : Basics of analog, digital and wireless communication.

Objective : To impart the new concepts in advanced wireless communications.

Outcome : Students will able to understand the latest technologies used in advanced wireless communication systems.

Unit I: Introduction **12 Hours**

Introduction about wireless communication - technical challenges of wireless communication-applications; Cellular architecture - frequency reuse - channel assignment - handoff - coverage and capacity improvement; Multiple access: FDMA/CDMA/TDMA/SDMA.

Unit II: Propagation principles **12 Hours**

Propagation principles: Propagation mechanisms - channel modeling methods - radio channels-indoor channels - outdoor channels - fading channels ; Mobile Radio Propagation : Large scale path loss - path loss and propagation models - small scale fading - types of small scale fading-parameters of mobile multipath channels - statistical models for multipath fading channels.

Unit III: Modulation and Detection **12 Hours**

Digital modulation: Structure of a wireless communication link - linear and constant envelope modulation techniques for wireless communication - error performance in fading channel; Transmission system; Combined fast and slow fading - equalization - different detection techniques used in wireless communication.

Unit IV: MIMO Systems **12 Hours**

Types of MIMO Systems: Beam forming - spatial multiplexing - basic space time code design principles - Alamouti scheme - orthogonal and quasi orthogonal space time block codes - space time trellis codes - representation of space - performance analysis for space-time Trellis codes - comparison of space-time block and Trellis codes.

Unit V: Activities Based Learning **12 Hours**

Simulation of minimum of (two) modulation, multiple access technique and MIMO systems for wireless communication system using related tools.

Reference Books:

1. Andreas Molisch F, "Wireless Communications", John Wiley and Sons Ltd., 2011.
2. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
3. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, Prentice Hall of India, 2005.
4. Guillaume De La Roche, Andres Alayon Glazunov and Ben Allen, "LTE – Advanced and Next Generation Wireless Networks: Channel Modelling and Propagation", John Wiley and Sons Ltd., 2013
5. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
6. Michel Daoud Yacoub, "Wireless Technology: Protocols, Standards, and Techniques", CRC Press, 2002.
7. Jafarkhani H, "Space-Time Coding: Theory & Practice", Cambridge University Press, 2005.

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ECIS 523

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 524	INFORMATION AND NETWORK SECURITY	L	T	P	4	60
		3	1	0		

Prerequisite : Analog and digital communication

Objective : To study the various security attacks- data security and network security algorithms and wireless security mechanism.

Outcome : Students will understand the various symmetric and asymmetric cryptographic techniques- authentication mechanism and network security.

Unit I: Introduction to Cryptography **12 Hours**

Security issues: Security problems in computing - attacks - security services - security mechanism - OSI security architecture - standard setting organizations; Need for cryptographic techniques- substitution - transposition - block ciphers.

Unit II: Data Security and Authentication **12 Hours**

Triple DES with two keys - stream cipher - RC4 - RSA algorithm - elliptical curve cryptography algorithm; MD5 - HASH algorithm - SHA 512 logic - Digital signature standards.

Unit III: Network Security **12 Hours**

Network Security: IP security overview - IP security architecture - authentication header - encapsulating security payload - combining security association - key management- web security considerations - secure socket layer and transport layer security - secure electronic transaction - security in GSM - security in 3G, 4G and 5G beyond.

Unit IV: System Security **12 Hours**

Intruders and intrusion detection: Malicious software - viruses and related threats - virus counter measures - distributed denial of service attack - firewalls design principles - trusted systems.

Unit V: Activities Based Learning **12 Hours**

Simulation of minimum of (three) public key and private key cryptography algorithms- authentication algorithms using related tools.

References Books:

1. Bernard S and Pabitra K R, "Digital Communications: Fundamentals and Applications", 2nd Edition, Pearson Edition, 2009.
2. Stallings W, "Cryptography and Network Security", 4th Edition, Prentice Hall, 2006.
3. Thomas S, Cover M and Joy A T, "Elements of Information Theory", 2nd Edition, John Wiley & Sons, 2006.
4. MacKay J C D, "Information Theory, Inference and Learning Algorithms", 2nd Edition, Cambridge University Press, 2003.
5. McEliece J R, "The Theory of Information and Coding", 2nd Edition, Cambridge University Press, 2002.

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1. https://www.cl.cam.ac.uk/teaching/1314/InfoTheory
2. http://gva.noekeon.org/QCandSKD/QCandSKD-introduction.html

ECIS 524

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 530	ADVANCED ELECTROMAGNETICS	2	1	0	3	45

Prerequisite : Basic knowledge of electromagnetic theory.

Objective : To develop the skills required to solve problems related to harmonic electromagnetic fields and momentum methods.

Outcome : The students will be able to analyze EFIE, MFIE for any type of microwave circuits

Unit I: Electromagnetic Waves **9 Hours**

Maxwell Equations: Integral and differential form - constitutive relations - time dependent wave equations - boundary conditions - polarization - time harmonic fields - Poynting theorem - mode concepts - guided waves - TE & TM waves in a rectangular waveguide and circular waveguide - the coaxial transmission line - Smith chart and its applications.

Unit II: Theorems and Concepts **9 Hours**

Source concept: Duality - uniqueness; Image Theory: Equivalence principle - fields in half space - the induction theorem - reciprocity – Green's function - tensor Green's function - integral equation; Construction of solutions; Radiation fields.

Unit III: Time Varying Harmonic Electromagnetic Fields **9 Hours**

Introduction: Maxwell equations - differential and integral form - constitutive parameters and relations - circuit field relations - boundary conditions - sources along boundary - time harmonic electromagnetic fields - Maxwell equations in differential and integral form - power and energy.

Unit IV: Integral Equation in Momentum Method **9 Hours**

Introduction: Integral equation method - electro charge distribution - integral equation - radiation pattern - point matching method - basis function - moment method electric and magnetic field integral equations; Finite diameter wires – Pocklington's integral equation- Hallen's integral equation.

Unit V: Activities Based Learning **9 Hours**

Simulation study of Green's function – Green's function for sturm – Green's function in two dimensions - double series method - single series expansion method – Green's function in spectral domain – Green's function for unbounded region.

Reference Books:

1. Roger F H, "Time Harmonic Electromagnetic Fields", IEEE Press, Wiley, 2001.
2. David J G, "Introduction to Electrodynamics", 4th Edition, Cambridge University Press, 2017.
3. John D J, "Classical Electrodynamics", 3rd Edition, Wiley, 2009.

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2. http://freevideolectures.com/Course/2340/Electromagnetic-Fields.html
3. http://ocw.mit.edu/OcwWeb/Electrical-Engineering-and-Computer-Science/6-632
4. Electromagnetic-Wave-TheorySpring2003/Course Home/index.html

ECIS 530

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 531	DATABASE DESIGN	2	1	0	3	45

Prerequisite : Knowledge in Data structures, C language.

Objective : To make the students to understand the concepts in data processing and management.

Outcome : Students will be able to analyze and implement data processing techniques for various applications.

Unit I: Data Base System **9 Hours**

File system Vs DBMS - advantages of DBMS - queries in DBMS - structure of DBMS - entities - attributes - entity sets - features of ER model - the relational model.

Unit II: Relational Algebra **9 Hours**

Relational algebra - selection and projection set operations - renaming - joins – divisions - examples of algebra overviews - expressive power of algebra and calculus.

Unit III: SQL **9 Hours**

Form of basic SQL query - examples of basic SQL queries - introduction to nested queries - correlated nested queries set - comparison operators - aggregative operators - NULL values - comparison using null values - logical connectivity's – AND, OR and NOT - impact on SQL constructs - outer joins disallowing NULL values - complex integrity constraints in SQL0 triggers and active data bases.

Unit IV: Normalization **9 Hours**

Schema refinement - problems caused by redundancy - decompositions - problems related to decomposition - reasoning about FDS - FIRST, SECOND, THIRD normal forms - BCNF - loss less join decomposition - dependency preserving decomposition - schema refinement in data base design - multi valued dependencies - fourth normal form; Transactions and column control.

Unit V: Activities Based Learning **9 Hours**

Case study on implementation of data base management for the applications in banking, educational sector and online shopping.

Reference Books:

1. Elmasri and Navathe, "Data Base Management System", 7th Edition, Pearson, 2016.
2. Raghurama Krishnan and Johannes G, "Data Based Management Systems", 3rd Edition, Tata Mc Graw Hill, 2002.
3. Silberschatz A, Korth F H and Sudarshan S, "Data Base System Concepts", 6th Edition, Mc Graw Hill, 2017.
4. Date C J, "Introduction to data base systems", 8th Edition, Pearson Education, 2006.
5. Rob, Coronel and Morris, "Data Base Systems-Design, Implementation, and Management", 10th Edition, 2012.

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2. http://www.yourarticlelibrary.com/accounting/computerized-accounting/database-management-system-dbms-applications-uses-and-other-details/63278.
3. http://whatisdbms.com/application-and-uses-of-database-management-system-dbms/

ECIS 531

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 532	DATA MINING AND DATA WAREHOUSING	L	T	P	3	45
		2	1	0		

Prerequisite : Database Systems

Objective : To understand the advanced aspects of data warehousing and data mining, encompassing the principles and commercial application of the technologies.

Outcome : Students will be able to understand the emerging architectures behind the analysis and mining of "big data".

Unit I: Data Mining **9 Hours**

Data Mining: Functionalities- data preprocessing - data cleaning - data integration and transformation - data reduction - data discretization and concept hierarchy generation; Association rule mining: Efficient and scalable frequent item set mining methods - mining association rules - association mining to correlation analysis - constraint based association mining; web data mining.

Unit II: Classification and Prediction **9 Hours**

Classification and prediction issues; Classification: Decision tree - Bayesian - rule based - back propagation - support vector machines - associative classification - lazy learners - other classification methods, prediction accuracy and error measure; Evaluation of classifier or predictor - ensemble methods - model section.

Unit III: Cluster Analysis **9 Hours**

Cluster analysis: Introduction - partitional methods - hierarchical methods - density based methods - large databases - cluster software.

Unit IV: Data Warehousing and Business Analysis **9 Hours**

Data warehousing components - building a data warehouse - mapping the data warehouse to a multiprocessor architecture - DBMS schemas for decision support - data extraction - cleanup and transformation tools - metadata reporting - query tools and applications; Online Analytical Processing (OLAP) – OLAP and multidimensional data analysis.

Unit V: Activities Based Learning **9 Hours**

Simulation on Spatial Data Mining; Multimedia Data Mining; Text Mining, Mining the World Wide Web.

Reference Books:

1. Han J, Kamber M and Pei J, "Data mining concepts and techniques", 3rd Edition, Morgan Kaufmann Publishers, 2011.
2. Alex Berson and Stephen J. Smith, "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, 2007.
3. G. K. Gupta, "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.
4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Pearson Education, 2007.
5. Soman K.P., ShyamDiwakar and V. Ajay, "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.
6. Daniel T. Larose, "Data Mining Methods and Models", Wiley -Inderscience, 2006.
7. Pudi V., Krishana P.R., "Data Mining", 1st edition, Oxford University press, 2009.

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ECIS 532

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 533	EMBEDDED SYSTEM DESIGN AND ARCHITECTURE	L	T	P	3	45
		2	1	0		

Prerequisite : Basics knowledge on Computer peripherals and Programming in C.

Objective : Students to learn the understanding of embedded systems design concepts and also know typical engineering issues in software development.

Outcome : Students will be able to familiar with programming environment used to develop embedded systems and also understood the key concepts of embedded systems like I/O, timers, interrupts.

Unit I: Introduction to Embedded Systems **9 Hours**

Embedded system model - embedded standards - block diagrams - powering the hardware - embedded board using von Neumann model; Embedded processors: ISA architecture - different ISA models - application specific ISA models - general purpose ISA models.

Unit II: Processor and Memory **9 Hours**

Internal processor design: ALU - registers - control unit - clock - on chip memory - processor i/o - interrupts - processor buses - processor performance; Board memory: ROM - RAM - cache - auxiliary memory - memory management - memory performance - board buses; Arbitration and timing - PCI bus example - integrating bus with components - bus performance.

Unit III: AVR Microcontroller and ARM Architecture **9 Hours**

AVR architecture - memory organization - addressing modes - I/O Memory - EEPROM - I/O Ports - SRAM - timer - UART - interrupt structure - serial communication with PC - ADC/DAC interfacing; Arcon RISC Machine(ARM) - architectural inheritance - core and architectures - the ARM programmer's model - registers - pipeline - interrupts - ARM organization - ARM processor family - co-processors; Instruction set - thumb instruction set - instruction cycle timings.

Unit IV: Embedded Programming **9 Hours**

C and Assembly programming: Programming style - declarations and expressions - arrays, qualifiers and reading numbers - decision and control statements; Basics of PYTHON programming: syntax and style - python objects - dictionaries - comparison with C programming on conditionals and loops - files - input and output - errors and exceptions - functions - modules - classes and OOP - execution environment.

Unit V: Activities Based Learning **9 Hours**

Simulation of various interfaces using AVR/ARM/PIC microcontrollers for different applications (Home/Machine/Bio-Medical automation) using related software packages.

Reference Books:

1. Tammy N, "Embedded system architecture", Elsevier, 2006.
2. Labrosse J J, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", Paul Temme, 2011.
3. Wesley J C, "Core python application Programming", 3rd Edition, Pearson Education, 2016.
4. Mark J G, "Introduction to computing and programming in python – a Multimedia approach", 4th Edition, Pearson Education, 2015.

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3. http://esd.cs.ucr.edu/
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ECIS 533

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 534	IMAGE PROCESSING TECHNIQUES	2	1	0	3	45

Prerequisite: Fundamentals of signals and systems.

Objective : Make the students to understand the concepts used in image processing techniques and its analysis.

Outcome : Students will be able to work with various image processing techniques for real time applications.

Unit I: Digital Image Fundamentals **9 Hours**

Image fundamentals: Image acquisition - sampling and quantization - image resolution- basic relationship between pixels - color images - RGB, HSI and other models; Transform based models (DFT, DCT, DWT); Image enhancement: Spatial and frequency averaging - smoothening and sharpening filters.

Unit II: Segmentation and Denoising **9 Hours**

Image Segmentation: Edge detection - edge linking via Hough transform - thresholding- region based segmentation; Denoising: Maximum likelihood estimation - Bayesian estimators - model selection (MDL principle) - transform based denoising - adaptive Wiener filtering - soft shrinkage and hard thresholding.

Unit III: Image Compression **9 Hours**

Image compression: Basics of source coding theory (lossless and lossy) - vector quantization - codebook design - transform and sub band coding.

Unit IV: Image security and forensics **9 Hours**

Image Security: Cryptography and Steganography techniques- Chaos based and Non-Chaos based methods; Image forensics: Key photographic techniques-detection techniques for crime scene analysis.

Unit V: Activities Based Learning **9 Hours**

Simulation of preprocessing techniques - implementation of image processing techniques for real time applications - forensics analysis using related tools.

Reference Books:

1. Rafael C Gonzalez and Richard E Woods, "Digital Image Processing", 2nd Edition, Pearson Education, 2004.
2. Anil K Jain, "Fundamentals of Digital Image Processing", 3rd Edition, Pearson Education, 2002.
3. William K Pratt, "Digital Image Processing", 2nd Edition, John Wiley, 2002.
4. Milan Sonka et al, "Image Processing, Analysis and Machine Vision", 2nd Edition, Vikas Publishing House, 1999.
5. Prabat K Andleigh and Kiran Thakrar, "Multimedia Systems and Design", Prentice Hall India, 2007.
6. Tay Vaughan, "Multimedia Making It Work", McGraw Hill, 2011.
7. Parekh R, "Principles of Multimedia", Tata McGraw-Hill, 2006.
8. Robinson and Edward, "Introduction to Crime Scene Photography", Elsevier/Academia Press, 2012.
9. Herbert Blitzer, Karen Stein-Ferguson and Jeffrey Huang, "Understanding Forensic Digital Imaging", 1st Edition, Academic Press, 2008.

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1. www.imageprocessingplace.com/DIP-3E/dip3e_main_page.html
2. https://www.tutorialspoint.com/dip/
3. https://homepages.inf.ed.ac.uk/rbf/HIPR2/glossary.htm

ECIS 534

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 535	OPTICAL COMMUNICATION	2	1	0	3	45

Prerequisite : Sound knowledge on basic optics, optical communication, various modulation and detection schemes in optical communication.

Objective : To impart the concepts of multilevel modulation schemes, OFDM and MIMO for optical communication systems and nonlinear optics.

Outcome : : Students will able to understand the potential of physical layer of optical system and its applications.

Unit I: Introduction **9 Hours**

Prologue: Historical perspective -light sources – modulators; Fiber losses - signal dispersion - signal propagation - multi channel propagation - optical solutions - photonic crystal and Photonic Band Gap (PBG); Second order nonlinear optics: Second Harmonic Generation (SHG) - Sum Frequency Generation (SFG) - Difference Frequency Generation (DFG); Third order nonlinear optics: Third Harmonic Generation (THG) - Four Wave Mixing (FWM) - Self Focusing (SF).

Unit II: Modulation schemes **9 Hours**

Noise sources - channel impairments - optical transmission system - advanced modulation formats - multilevel modulation schemes - OFDM for optical communications - MIMO optical communication - polarization multiplexing - constrained (line or modulation) coding - Soliton based communication.

Unit III: Detection schemes **9 Hours**

Coherent detection of optical signals - optical coherent detection schemes - optical heterodyne detection - optical homodyne detection - optical intradyne detection - DPSK photonic systems - optical channel equalization - coherent optical OFDM detection - optical MIMO detection.

Unit IV: Optical Channel Estimation **9 Hours**

Optical channel capacity - calculation of information capacity - information capacity of systems with direct detection - capacity of optical OFDM systems - capacity of optical MIMO systems.

Unit V: Activities Based Learning **9 Hours**

Simulation of two dimensional photonic crystal, ring resonator and Y-shaped waveguide using 32-bit OPTIFDTD (freeware); Analyze second order nonlinearity and four-wave mixing through simulation using the same FDTD tools.

Reference Books:

1. Keiser G, "Optical Fiber Communication", 5th Edition, McGraw Hill, 2008.
2. Agrawal G P, "Fiber Optics Communication Systems", 4th Edition, Wiley, 2010.
3. Binh L N, "Advanced Digital Optical Communications", 2nd Edition, CRC Press, 2015.
4. William S and Ivan D, "OFDM for Optical Communications", Academic Press: Elsevier, 2010.
5. Ivan P K, Tingye L, and Alan E W, "Optical Fiber Communications VIB: Systems and Networks", 6th Edition, Academic Press: Elsevier, 2013.
6. Milorad C and Ivan B D, "Advanced Optical Communication Systems and Networks", Artech House, 2012.
7. Pierre L, "Fiber - Optic Communications", John Wiley and Sons, 2008.
8. Enrico F, "Optical Communication Theory and Techniques", Springer, 2006.
9. James N D, "Fiber-Optic Communications", Thomson Delmar Learning, 2005.
10. Rogers A J, "Understanding Optical Fiber Communications", Artech House, 2001.
11. Robert W Boyd, "Nonlinear Optics", 3rd Edition, Academic Press, 2008.

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2. http://www.optics.arizona.edu/academics/course/opti-632.html
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ECIS 535

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 536	SATELLITE COMMUNICATION	2	1	0	3	45

Prerequisite : Basics of digital and satellite communication.

Objective : To impart the orbital mechanics, space craft sub-systems and satellite link design

Outcome : Students will be able to analyze the advanced technical details behind the satellite link.

Unit I: Introduction and Satellite Access **9 Hours**

Orbits of Satellite: Low - medium - geo synchronous - angle period - returning period - orbital spacing - delay transponder - earth stations - antennas and earth coverage - altitude and eclipses; Multiple Access: Demand assigned FDMA - spade system - TDMA - satellite switched TDMA - CDMA.

Unit II: Space Segment and Earth Segment **9 Hours**

Space Segment: Power supply - altitude control - station keeping - thermal control - TT and C subsystem - transponders; Earth segment: Receive only home TV system - outdoor unit - indoor unit - master antenna TV system - community antenna TV system.

Unit III: Satellite Link Design **9 Hours**

Link Design: System noise temperature and G/T ratio - C/N design of uplink and downlink - error control for digital satellite link.

Unit IV: VSAT Systems **9 Hours**

VSAT systems: Network architectures - access control protocols - earth station engineering - antennas - link margins - system design procedure.

Unit V: Activities Based Learning **9 Hours**

Simulation of link budget for two satellite systems - simulation of transponders and antenna system using related tools.

References Books:

1. Timothy Pratt and Charles W. Bostain, "Satellite Communications", 2nd Edition, Wiley, 2012.
2. D. Roddy, "Satellite Communication", 4th Edition (Reprint), McGraw Hill, 2009.
3. Wilbur L. Pritchard, Hendri G. Suyderhoud and Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/ Pearson, 2007.
4. Tri T. Ha, "Digital Satellite Communication", 2nd Edition, McGraw Hill, 1990.
5. Brian Ackroyd, "World Satellite Communication and Earth Station Design", BSP Professional Books, 1990.

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2. http://ece564web.groups.et.byu.net
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ECIS 536

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 537	SOFTWARE ARCHITECTURE AND INTEROPERABILITY	2	1	0	3	45

Prerequisite: Basic knowledge in computational electromagnetics and fuzzy logic.

Objective : To learn the importance of software architecture, life cycle and Interoperability challenges.

Outcome : Students will be able to understand the basic principles of software architecture and interoperability.

Unit I: Introduction **9 Hours**

Software Architecture - architecture structures and views - importance of software architecture - predicting system quality - influencing organizational structure – improving cost and schedule estimates - context of software architecture.

Unit II : Life Cycle Architecture **9 Hours**

Architecture of agile projects - its requirements - designing and documentation - implementation and testing - architecture reconstruction and conformance; Architecture in cloud: Cloud definition - service model - economic justification - base mechanism - edge architecture - edge document system - SDLC - metropolis model.

Unit III: Interoperability **9 Hours**

Physical vs Virtual - data interoperability - semantic interoperability - organizational interoperability - eternal interoperability - important economic dimension - roadmap for IoT testing methodologies.

Unit IV: Quality Attributes **9 Hours**

Understanding quality attributes - availability - interoperability - modifiability - performance and security - testability - usability - quality attribute modeling and analysis.

Unit V: Activities Based Learning **9 Hours**

Case Study: Evolving software architecture for food and drug administration and generic drug application process; NATO Multilateral interoperability.

Reference Books:

1. Len Bass, Paul Clements and Rick Kazman, "Software Architecture in Practice", 3rd Edition Pearson, 2013.
2. Mary Shaw and David Garlan, "Software Architecture: Perspectives on an Emerging Discipline", Prentice Hall, 1996.
3. Ovidiu Vermesan and Peter Friess, "Internet of Things: Converging Technologies for Smart Environment and Integrated Ecosystems", River Publishers, 2013
4. Taylor R. N, Medvidovic N and Dashofy E M, "Software Architecture: Foundations, Theory, and Practice", Wiley, 2009.

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3. https://handbookofsoftwarearchitecture.com/?cat=14

ECIS 537

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 550	ADVANCED TECHNOLOGIES IN WIRELESS NETWORKS	L	T	P	3	45
		2	1	0		

Prerequisite : Basics knowledge of computer and wireless networks.

Objective : To learn about the advanced topics in wireless networks with their architectures.

Outcome : Students will be able to understand the various technologies in wireless networks.

Unit I: Wireless Area Networks **9 Hours**

WPAN: System model - protocol stack of IEEE 802.15; Bluetooth: Network architecture - operation - specification; Radio Frequency Identification (RFID): Types and specifications; ZIGBEE and WBAN: section and architecture; WLAN: Network architecture - protocol stack of IEEE 802.11 - physical layer and MAC layer mechanism; WiMAX: BWA - issues and challenges of WiMAX - network architecture - protocol stack of IEEE 802.16 - differences between IEEE 802.11 and IEEE 802.16.

Unit II: Wireless Sensor Network **9 Hours**

Issues - design challenges - characteristics and architecture of wireless sensor network - classification - MAC protocols - routing schemes - security - enabling technologies for sensor network.

Unit III: Wireless Internet **9 Hours**

IP for wireless domain - mobile IP - IPv6 advancements - mobility management functions - location management - registration and handoffs; TCP in wireless domain: TCP over wireless - types - mobile transaction - impact of mobility; Wireless security and standards.

Unit IV: Wideband Wireless Technologies **9 Hours**

UWB Radio Communication: Fundamentals of UWB - major issues - operation of UWB systems - comparisons with other technologies - advantages and disadvantages; LTE: System architecture - frame structure – LTE - FDD vs TDD comparison; LTE Advanced: Network architecture - frame structure and its characteristics; 5G networks: Technical challenges- architecture.

Unit V: Activities Based Learning **9 Hours**

Simulation of minimum of five wireless networks standards using related tools.

Reference Books:

1. Kaveh Pahlavan and Prashant Krishnamurthy, "Principle of Wireless Networks - A Unified Approach", Prentice Hall of India, 2006.
2. William Stallings, "Wireless Communication and Networks", 2nd Edition, Prentice Hall, 2005.
3. Clint Smith and Daniel Collins, "3G Wireless Networks", 2nd Edition, Tata McGraw Hill, 2007.
4. Vijay Garg K, "Wireless Communications and Networks", 2nd Edition, Morgan Kaufmann Publishers (Elsevier), 2007.
5. Amitabha Ghosh and Rapeepat Ratasuk, "Essentials of LTE and LTE-A", Cambridge University Press, 2011.

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2. www.tutorialspoint.com/wimax/
3. http://www.infotech.monash.edu.au/units/archive/2012/s2/fit5083.html
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ECIS 550

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 551	MANAGEMENT INFORMATION SYSTEMS	2	1	0	3	45

Prerequisite : Basic knowledge about information systems.

Objective : To study the concepts of information systems and their general applications.

Outcome : Students will be able to develop system design essential for management information systems.

Unit I: Introduction **9 Hours**

Information Systems (IS): Business models - IS architecture; Modern information system: Systems development life cycle - structured methodologies - designing computer based methods – procedures - designing structured programs.

Unit II: Integrated Construction Management **9 Hours**

Integrated Construction Management - information system - project management information system- functional areas finance - marketing production - personnel levels - DSS - EIS - ES- comparison, concepts and knowledge representation - managing international information system.

Unit III: Hardware Software Overview **9 Hours**

Information Technology (IT) trends - IT trends in hardware - information system software - application software - software concepts - geographical information systems - electronic data interchange.

Unit IV: System Design **9 Hours**

System design: Data flow diagrams - Decision analysis -Structured analysis - structured system design - module design - design of programs.

Unit V: Activities Based Learning **9 Hours**

Case study: Financial Management Information System (FMIS); Marketing MIS: Product development and delivery - sales report.

Reference Books:

1. Kenneth C Laudon and Jane Price Laudon, "Management Information Systems Organization and Technology", Prentice Hall, 2006.
2. Gordon B. Davis, "Management Information System: Conceptual Foundations Structure and Development", McGraw Hill, 2004.
3. Joyce J Elam, "Case series for Management Information Systems. Simon and Schuster", Custom Publishing, 2006.
4. Ralph H Sprague and Huge J Watson, "Decision Support for Managers", Prentice Hall, 2006.
5. Michael W. Evans and John J Marciniah, "Software Quality assurance and Management", John Wiley and Sons, 2007.
6. Card and Glass, "Measuring Software Design quality", Prentice Hall, 2000.

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2. http://nptel.ac.in/courses/122105022/
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ECIS 551

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 552	MODELING AND SIMULATION OF COMMUNICATION SYSTEMS	2	1	0	3	45

Prerequisite : Basic concepts of Probability, Random processes, Numerical methods and Digital Signal Processing.

Objective : To impart the basic concepts of modeling and simulation of communication.

Outcome : Students will be able to apply modeling and computational techniques to problems in communication field.

Unit I: Introduction **9 Hours**

Simulation and modeling methodology: Review of random processes - univariate and multivariate models - transformation of random variables - bounds and approximations; Random process models: Markov and ARMA sequences - Poisson process - Gaussian process; Random number generation; Generation of random sequences; Testing random number generators.

Unit II: Modeling of Transmitter and Receiver subsystems **9 Hours**

Information sources - channel coding - radio frequency and optical modulation; Demodulation and detection - filtering; Multiple Access: Issues in the simulation of multiple access.

Unit III: Communication channels and models **9 Hours**

Fading and multipath channels; Free space channel; Conducting and Guided wave media; Finite state channel models; Methodology for simulating communication systems operating over fading channels.

Unit IV: Estimation of parameters and performance **9 Hours**

Estimation of parameters through simulation: Quality of an estimator - estimating average level - average power - power spectral density - delay and phase; Estimation of performance measures from simulation: SNR; Estimating performance measures for digital systems: The Monte Carlo method, importance sampling method; Variance reduction techniques.

Unit V: Activities Based Learning **9 Hours**

Simulation study: Generating PDF for the Gaussian and non-Gaussian distributions; Modeling of transmitter and receiver subsystems; Estimation of parameters and performance for communication system.

Reference Books:

1. Jeruchim M C, Philip B and Samshanmugam K, "Simulation of Communication Systems: Modeling, Methodology and Techniques", 2nd Edition, Kluwer Academic Publisher, 2014.
2. Raj Jain, "The Art of Computer Systems Performance Analysis", John Wiley and Sons, 2008.
3. William H T, Samshanmugan K, Rappaport T S and Kosbar K L, "Principles of Communication Systems Simulation with Wireless Applications", 1st Edition, Pearson Education, 2011.
4. Averill M L, "Simulation Modeling and Analysis", 5th Edition, McGraw Hill, 2017.

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1. http://ocw.korea.edu/ocw/college-of-engineering/communciation-systems-and-lab
2. http://www.mathworks.in/communications/wireless-wired-channel-modeling.html

ECIS 552

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 553	MULTIMEDIA SYSTEMS	L	T	P	3	45
		2	1	0		

Prerequisite : Fundamentals of communication systems and computer networks

Objective : To understand the various concepts of hardware and software used in multimedia and to get familiar with the various file formats used in multimedia.

Outcome : Students will be able to work with various multimedia techniques for real time applications.

Unit I: Introduction **9 Hours**

Multimedia system architecture - multimedia elements - media and data stream - data stream characteristics - main properties of multimedia system - evolving technologies for multimedia systems - multimedia databases - multimedia applications.

Unit II: Multimedia Input and Output Technologies **9 Hours**

Key technology issues - pen input - image and video display systems - video images and animation - full motion video - sensors for TCV cameras - print output technologies - image scanners - digital audio and computers video technology raster scanning principles.

Unit III: Wireless Multimedia Communication **9 Hours**

End to end QOS provisioning in wireless multimedia networks - adaptive framework - MAC layer QOS enhancements in wireless networks - a hybrid MAC protocol for multimedia traffic - call admission control in wireless multimedia networks - a global QOS management for wireless networks.

Unit IV: Storage and Retrieval Technologies **9 Hours**

Storage System Architecture- Data Placement on Disks - Tertiary Storage Devices - Contiguous Placement on Hierarchical Storage Systems - Staging Methods - Cache replacement policy.

Unit V: Activities Based Learning **9 Hours**

Case study: Integration of academic and business sector activities - Computer-Based Training (CBT) - Computer Aided Learning (CAL) technologies.

Reference Books:

1. Saeed Vaseghi, "Multimedia Signal Processing: Theory and Applications in Speech, Music and Communications", Wiley publisher, 2007.
2. Fred Halsall, "Multimedia Communications", Addison Wesley Publisher, 2000.
3. Ralf Steinmetz and Klara Nahrstedt, "Multimedia, Computing, Communications and Applications", Prentice Hall, 1995.
4. Tay Vaughan, "Multimedia: Making it work", 5th Edition, Mc Graw Hill, 2001.
5. Weixel, Fulton, Barksdale. Morse, "Multimedia Basics", Easwar Press, 2004.
6. Lynne Dunckley, "Multimedia Databases: An Object-Relational Approach", Pearson Education, 2003.
7. Ze-Nian Li, and Mark S. Drew, "Fundamentals of Multimedia", Pearson Prentice Hall, October 2003.
8. Ling Guan, Yifeng He and Sun-Yuan Kung, "Multimedia Image and Video Processing", 2nd Edition, CRC press, 2017.
9. Neetu Sharma, Monika Kansal and Rajesh Kumar Maurya, "Multimedia System and its Applications", Global Vision Publishing House, 2014.

Hyperlinks:

1. https://www.tutorialspoint.com/basics_of_computer_science/basics_of_computer_science_multimedia.htm
2. http://www.cse.fau.edu/~borko/Seminar_MS.pdf
3. https://www.cc.gatech.edu/fac/Ann.Chervenak/8113/8113.html

ECIS 553

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 554	NETWORK ADMINISTRATIVE SYSTEMS	2	1	0	3	45

Prerequisite : Knowledge in Computer Networks, Network Security.

Objective : To make the students to understand the concepts in network layers, protocols.

Outcome : Students will be able to analyze and implement network management techniques for various applications.

Unit I: Introduction **9 Hours**

Internet administration and standards - OSI model and TCP/IP protocol; Examples of networks: novel networks – Arpanet - Internet; Network topologies: LAN- MAN- WAN; Model for inter network security-protection through cryptography - the role of cryptography in network security.

Unit II: Automated Design and Network Management Tools **9 Hours**

Network design tools - network management protocols (CMISE/CMIP, SNMP, and RMON) - network management agents - the management station - network management implementation - web-based network management - other network management strategies.

Unit III: Simple Network Management Protocol (SNMP) **9 Hours**

Introduction- concept of network management - change management - SNMP communities - structure of management information - SNMP operations - host management revisited - remote management revisited.

Unit IV: SNMP adaptation **9 Hours**

General trap generation problem - logger database - throw care - VERITAS disk check - port monitor -service monitoring - simple SNMP agent - switch port control - wireless networking.

Unit V: Activities Based Learning **9 Hours**

Simulation: Secure data retrieval for decentralized disruption-tolerant networks, network traffic monitoring and windows remote manager, active source routing protocol for mobile networks using related software packages.

Reference Books:

1. Teresa C P, "Network Design-Management and Technical Perspectives", 2nd Edition, CRC Press, 2004.
2. Douglas M and Schmidt K, "Essential SNMP: Help for System and Network Administrators", 2nd Edition, O'Reilly, 2005.
3. Thomas L A, "The Practice of System and Network Administration", 2nd Edition, Addison Wesley, 2007
4. William Stallings, "Cryptography and Networking Security, Principles and Practice", 7th Edition, Pearson, 2016.
5. Andrew S Tanenbaum, "Computer Networks", 4th Edition, Pearson, 2002.
6. Behrouz A. Forouzan, "Data Communications and Networking", 5th Edition, Mc Graw Hill, 2017.

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1. https://ns2blogger.blogspot.in/p/introduction-to-wired-topology.html
2. http://slogix.in/how-to-create-mobile-ad-hoc-network-manet-in-ns2
3. https://www.solarwinds.com/basics-of-network-monitoring

ECIS 554

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 555	PATTERN RECOGNITION AND ARTIFICIAL INTELLIGENCE	L	T	P	3	45
		2	1	0		

Prerequisite : Basic concepts of probability theory and random process.

Objective : To help the students to gain in-depth knowledge in pattern recognition and artificial intelligence.

Outcome : Students will be able to apply pattern recognition and artificial intelligence techniques for signal and image processing application.

Unit I: Introduction to Pattern Recognition **9 Hours**

Introduction: Probability- statistical decision making- nonparametric decision making- patterns and features - training and learning in pattern recognition - pattern recognition approach- different types of pattern recognition.

Unit II: Clustering **9 Hours**

Unsupervised learning: Hierarchical clustering - graph theories approach to pattern clustering - fuzzy pattern classifier - application of pattern recognition in medicine.

Unit III: Artificial Intelligence **9 Hours**

Artificial intelligence: Intelligent agents - perception and language processing - problem solving - searching - heuristic searching - game playing - logics - logical reasoning.

Unit IV: Expert Systems **9 Hours**

Expert Systems – components - production rules - backward vs forward reasoning - statistical reasoning - certainty factors - measure of belief and disbelief - Meta level knowledge - introspection.

Unit V: Activities Based Learning **9 Hours**

Simulation of range images generation - extraction of geometric elements - automatic scene generation - scene recognition - geometrical hashing using related tools.

Reference Books:

1. MacKay D.J.C, "Information Theory, Inference, and Learning Algorithms", Cambridge University Press, 2003.
2. Devi, Susheela V, Murty, Narasimha M, "Pattern Recognition: An Introduction", Universities Press, Hyderabad, 2011.
3. Theodoridis S and Koutroumbas K, "Pattern Recognition", 4th Edition. Academic Press, 2009.
4. Mishra R B, "Artificial Intelligence", PHI, India, 2010.
5. Russell S and Norvig N, "Artificial Intelligence: A Modern Approach", Prentice Hall Series in Artificial Intelligence. 2003.
6. Bishop, C M, "Pattern Recognition and Machine Learning", Springer. 2007.

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1. https://www.tutorialspoint.com/biometrics/pattern_recognition_and_biometrics.htm
2. http://www.cedar.buffalo.edu/~srihari/CSE555/
3. https://www.ibm.com/developerworks/library/cc-beginner-guide-machine-learning-ai-cognitive/index.html

ECIS 555

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 556	RADIATION SYSTEMS	2	1	0	3	45

Prerequisite : Electromagnetics and antenna theory.

Objective : To learn the antenna radiation concepts, different types of antenna and their design methodology.

Outcome : Students will be able to design different types of antenna for various applications.

Unit I: Concepts of Radiation and Antenna Fundamentals **9 Hours**

Physical concept of radiation: Radiation from surface and line current distributions - fundamental parameters of antennas - Friss transmission equation - radiation integrals and auxiliary potential functions - near and far field regions - reciprocity and reaction theorems - radiation hazards and solutions.

Unit II: Aperture and Reflector Antennas **9 Hours**

Huygen's principle - radiation from rectangular and circular apertures - design considerations - Babinets principle - radiation from sectoral - pyramidal - conical and corrugated horns - design concepts of parabolic reflectors and Cassegrain antennas.

Unit III: Broadband Antennas **9 Hours**

Principles - frequency independent antennas - design and properties of log periodic - Yagi-Uda antennas - loop antennas - helical antennas - biconical antennas - broadcast antenna - spiral antenna and slot antennas.

Unit IV: Microstrip Antennas **9 Hours**

Microstrip Antennas: Radiation mechanism - parameters and applications - feeding methods - design of rectangular and circular patch - impedance matching of microstrip antennas - broadband - compact and tunable microstrip antennas.

Unit V: Activities Based Learning **9 Hours**

Design, simulation and analysis of different antennas for wireless applications using related simulation tools.

Reference Books:

1. Jordan E C and Balmain K G, "Electromagnetic Waves and Radiating Systems", 2nd Edition, Pearson Education, 2015.
2. Balanis C A, "Antenna Theory: Analysis and Design", 4th Edition, John Wiley and Sons, New Jersey, 2016.
3. Kraus J D and Marhefka R J, "Antennas for All Applications", 3rd Edition, Tata McGraw Hill, 2002.
4. Elliot R S, "Antenna Theory and Design", Revised edition, John Wiley and Sons, India, 2006.
5. Girish Kumar and Ray K P, "Broadband Microstrip Antennas", Artech House, 2003.

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1. http://www.nptel.ac.in/courses/117107035/
2. http://www.nptel.ac.in/courses/108101092/
3. http://www.nptel.ac.in/courses/108104099/
4. http://www.nptel.ac.in/courses/108104087/

ECIS 556

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 557	SPEECH AND AUDIO PROCESSING	2	1	0	3	45

Prerequisite : Knowledge in signals and systems, digital signal processing, MATLAB

Objective : To impart the concepts of speech analysis using various methods, speech recognition and text-to-speech synthesis methods.

Outcome : Students will able to understand the basic concepts of speech, different ways of analyzing the speech signals, applying processing techniques on speech signals.

Unit I: Introduction **9 Hours**

Introduction to Phonetics and Phonology - models of speech production - ear physiology - psychoacoustics and speech perception; Basic audio processing: Normalization - audio processing – segmentation - analysis window sizing – visualization - sound generation.

Unit II: Speech Analysis Methods **9 Hours**

Short-Time analysis: Short-Time energy and zero crossing rate - Short-Time Autocorrelation Function (STACF) - Short-Time Fourier Transform (STFT) - sampling STFT in time and frequency domain - speech spectrogram - Short-Time Fourier synthesis; Homomorphic analysis: Cepstrum and complex cepstrum - Short-Time cepstrum - cepstrum computation - Short-Time Homomorphic filtering of speech - application to pitch detection and pattern recognition.

Unit III: Linear Predictive Analysis **9 Hours**

Linear prediction and speech model - computation of prediction coefficients - The Lenin-Durbin Recursion - LPC Spectrum - equivalent representation.

Unit IV: Text-to-Speech Synthesis Methods and Automatic Speech Recognition **9 Hours**

Text Analysis: Evolution of speech synthesis systems - Unit Selection methods - TTS applications - TTS future needs; Automatic Speech Recognition (ASR): Problem of ASR- building a speech recognition system - decision processes in ASR - representative recognition performance - challenges in ASR technology.

Unit V: Activities Based Learning **9 Hours**

Simulation on speech analysis, speech synthesis and speech recognition using related simulation tools.

Reference Books:

1. Ian McLaughlin, "Applied Speech Audio Processing", Cambridge University Press, 2009.
2. Rabiner L R and Schafer R W, "Introduction to Digital Speech Processing", Now Publishers Inc., 2007.
3. Ben G, Nelson M and Dan, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", 2nd Edition, John Wiley and Sons, 2011.
4. Holmes J and Holmes W, "Speech Synthesis and Recognition", 2nd Edition, CRC Press, 2001.
5. Rabiner L R and Schafer R W, "Theory and Applications of Digital Speech Processing", 1st Edition, Prentice Hall, 2011.

Hyperlinks:

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2. http://www.ece.ucsb.edu/Faculty/Rabiner/ece259/digital%20speech%20processing%20course/Matlab%20Code/matlab_speech_2011.pdf
3. http://research.iaun.ac.ir/pd/mahmoodian/pdfs/UploadFile_2643.pdf

ECIS 557

Course Code	Name of the Course	Periods			Credits	Total Hours
ECIS 630	ADVANCED DISTRIBUTED SYSTEMS	L	T	P	3	45
		2	1	0		

Prerequisite : Fundamentals of Peer-to-Peer Systems and distributed Algorithms

Objective : To understand the fundamental principles and models underlying the theory, algorithms, and systems aspects of distributed systems.

Outcome : The students will be able to understand the fundamental principles and models underlying all aspects of distributed computing

Unit I: Introduction **9 Hours**

Definition - architectural models (client-server) - characteristics and challenges of distributed systems; Time: physical and logical time - event ordering - clock synchronization - message delivery ordering.

Unit II: Communication **9 Hours**

Multithreaded clients and services - Virtualization and virtual machines - Code migration – RPC - Message and stream oriented communication - Multicast communication.

Unit III: Synchronization and Naming **9 Hours**

Synchronization algorithms; Naming: Flat and structured naming- Attribute based naming; Consistency models and replica management.

Unit IV: Fault Tolerance and Security **9 Hours**

Fault Tolerance: Failure models- Failure detection- Algorithms for fault tolerance-Recovery from failure in distributed systems; Security: Distribution of security mechanisms- Access control- Security Management.

Unit V: Activities Based Learning **9 Hours**

Analyze the consistency properties of some existing system, either live or open source- Build a distributed storage system (or extend an existing one) that minimizes the amount of data.

Reference Books:

1. George Coulouris, Dollimore J and Kindberg T, "Distributed Systems - Concepts and Design", 4th Edition, Pearson India, 2009
2. Gerard Tel, "Introduction to Distributed Algorithms", Cambridge University Press, 1994
3. M.Sasikumar, et.al, "Introduction to Parallel Processing", PHI, New Delhi, 2000
4. Andrew S. Tanenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms", 2nd Edition, Pearson publications, 2007.
5. Kenneth P. Birman, "Reliable Distributed Systems: Technologies, Web Services and Applications", Springer Publisher, 2005.
6. Paulo Veríssimo and Luís Rodrigues, "Distributed Systems for System Architects", 1st Edition, Springer, 2012.

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1. http://www.cse.iitd.ernet.in/~srsarangi/csl860/docs/intro.pdf
2. https://eclass.uoa.gr/modules/document/file.php/D245/2015/DistrComp.pdf

ECIS 630

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 631	BIG DATA ANALYTICS	2	1	0	3	45

Prerequisite : Basic concepts of Image processing and Machine learning

Objective : To explore the fundamental concepts of big data analytics and analyze the big data using intelligent techniques.

Outcome : The students will be able to understand the practical foundation level knowledge that enables them for immediate and effective participation in big data projects.

Unit I: Introduction to Big Data **9 Hours**

Introduction – distributed file system – big data and its importance - drivers for big data - big data analytics - algorithms using map reduce - matrix-vector multiplication by map reduce - big data applications.

Unit II: Data Analysis **9 Hours**

Regression modeling - multivariate analysis - Bayesian modeling - inference and Bayesian networks - support vector and kernel methods; Neural networks: Learning and generalization - competitive learning - principal component analysis and neural networks; Fuzzy logic: Extracting fuzzy models from data - fuzzy decision trees.

Unit III: Frequent Itemsets and Clustering **9 Hours**

Mining frequent itemsets - market based model – Apriori algorithm – handling large data sets in main memory – limited pass algorithm; Clustering techniques: Hierarchical – K-Means – clustering high dimensional data – CLIQUE and PROCLUS – frequent pattern based clustering methods.

Unit IV: Frameworks and Visualization **9 Hours**

Map reduce - Hadoop, Hive, MapR - Sharding - NoSQL databases - S3 - Hadoop distributed file systems; Visualizations: Visual data analysis techniques; Interaction techniques: Systems and analytics applications - analytics using statistical packages.

Unit V: Activities Based Learning **9 Hours**

Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.

Reference Books:

1. Michael Berthold and David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
3. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
4. Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons, 2007
5. Pete Warden, "Big Data Glossary", O'Reilly, 2011.
6. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", 2nd Edition, Elsevier, Reprinted, 2008.

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2. https://www.youtube.com/watch?v=aRReF-lvyPQ
3. https://www.planet-data.eu/sites/default/files/presentations/Big_Data_Tutorial_part4.pdf
4. https://intellipaat.com/blog/big-data-tutorial-for-beginners/

ECIS 631

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 632	CLOUD STORAGE AND COMPUTING	2	1	0	3	45

Prerequisite : Fundamentals of Networking and Distributed Computing

Objective : To understand the different deployment models of cloud and different services offered by cloud

Outcome : The students will be able to understand the basics of cloud, different services and security issues in cloud. In a nutshell, this course on cloud computing provides information on fundamental aspects of the cloud environment.

Unit I: Introduction **9 Hours**

Cloud computing components - infrastructure-services - storage applications - database services – deployment models of cloud - services offered by cloud - benefits and limitations of cloud computing.

Unit II: Virtualization Fundamentals **9 Hours**

Virtualization – enabling technology for cloud computing - types of virtualization - server virtualization - desktop virtualization – memory virtualization – application and storage virtualization - tools and products available for virtualization.

Unit III: Software as a Service (SaaS) and Platform as a Service (PaaS) **9 Hours**

Getting started with SaaS - understanding the multitenant nature of SaaS solutions - understanding open SaaS solutions - understanding service oriented architecture - PaaS- benefits and limitations of PaaS.

Unit IV: IaaS and Cloud Data Storage **9 Hours**

Understanding IaaS - improving performance through load balancing - server types within IaaS solutions- utilizing cloud based NAS devices – understanding cloud based data storage - cloud based backup devices - cloud based database solutions - cloud based block storage.

Unit V: Activities Based Learning **9 Hours**

Client side programming model: Web clients - mobile clients; Server side programming Technologies: AJAX, JSON, web services (RPC, REST) using related simulation tools.

Reference Books:

1. Anthony T. Velte, Toby J. Velte and Robert Elsenpeter, "Cloud Computing: A Practical Approach", Tata McGraw Hill Edition, 2010.
2. Kris Jamsa, "Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security and more", Jones & Bartlett Learning Company LLC, 2013.
3. Ronald L. Krutz and Russell Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley Publishing Inc., 2010.
4. Greg Schulz, "Cloud and Virtual Data Storage Networking", Auerbach Publications, 2011.

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1. https://www.guru99.com/cloud-computing-for-beginners.html
2. http://www.rfwireless-world.com/Tutorials/cloud-storage-tutorial.html
3. http://www.tutorialspoint.com/articles/how-cloud-storage-works

ECIS 632

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 633	COGNITIVE RADIO	2	1	0	3	45

Prerequisite : Fundamentals in wireless networks

Objective : To understand the requirements in designing software defined radios and cognitive radio with its functionalities.

Outcome : Students will be able to design the wireless network based on cognitive radio technology

Unit I: Introduction **9 Hours**

Fundamentals of communication networks: New challenges - multiple access schemes - cross layer design and optimization; Multicarrier modulation and equalization - ISI; RF spectrum and regulation: Regulatory issues of cognitive access.

Unit II: SDR Architecture **9 Hours**

Software Defined Radio: Evolution - essential functions of the Software Defined Radio - architecture goals - quantifying degrees of programmability - top level component topology - computational properties of functional components - interface topologies among plug and play modules - architecture partitions - merits and demerits of SDR - problems faced by SDR.

Unit III: CR Architecture **9 Hours**

Cognitive radio network architectures: Architectures for spectrum sharing - network optimization - topology aware CRN architectures - Haykin dynamic spectrum architecture.

Unit IV: CR Network Security **9 Hours**

Primary user emulation attacks - security vulnerabilities in IEEE 802.22 - security threats to the radio software.

Unit V: Activities Based Learning **9 Hours**

Simulation of CR & SDC network using related tools.

Reference Books:

1. Alexander M. Wyglinski, MaziarNekovee, and Thomas Hou Y, "Cognitive Radio Communications and Networks - Principles and Practice", Elsevier Inc., 2010.
2. Kwang-Cheng Chen and Ramjee Prasad, "Cognitive Radio Networks", John Wiley & Sons Ltd., 2009.
3. Khattab, Ahmed, Perkins, Dmitri, Bayoumi and Magdy, "Cognitive Radio Networks - From Theory to Practice", Springer Series: Analog Circuits and Signal Processing, 2009.
4. Mitola J, "Cognitive Radio: An Integrated Agent Architecture for software defined radio", Doctor of Technology thesis, Royal Inst. Technology, Sweden, 2000.
5. Simon Haykin, "Cognitive Radio: Brain –empowered wireless communications", IEEE Journal on selected areas in communications, volume 23, no.2, page no.201-220, Feb 2005.
6. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran and ShantidevMohanty, "NeXt generation / dynamic spectrum access / cognitive radio wireless networks: A Survey, Elsevier Computer Networks", volume 50, page no.2127-2159, May 2006.
7. Arslan H, "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", University of South Florida, USA, Springer, 2007.

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1. http://www.radio-electronics.com/info/rf-technology-design/cognitive-radio-cr/technology-tutorial.php
2. http://www.sciencedirect.com/science/book/9780123747150
3. http://www.xgtechnology.com/innovations/cognitive-radio-networks/

ECIS 633

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 634	CONVERGENCE TECHNOLOGIES	2	1	0	3	45

Prerequisite : Basics of wireless networks, elementary concepts in probability, optimization related to communication systems.

Objective : To familiarize in the convergence technologies in respect of network design and performance measures.

Outcome : Students will be able to enumerate the functions and importance of internetworking/ interoperability of advanced wireless technologies

Unit I: Introduction **9 Hours**

Evolution towards convergence: Next generation network concept - framework for examining next generation and evolving networks - examples of application of framework - enabling mobile network technologies - opportunities and threats to the mobile converging service market.

Unit II: Switching networks and convergence standards **9 Hours**

Switching networks: Packet switched networks - Circuit switched networks; Convergence Standards: VOIP convergence - H.323 protocol - SIP - Media Gateway Control Protocol (MGCP) - MEGACO; Wireless standards: IEEE 802.11 - HYPERLAN - IEEE 802.16 - wireless ATM - wireless convergence - sensor networks - ZigBee and RFID.

Unit III: IP Telephony **9 Hours**

IP Telephony : Network architecture - IP Voice - VoIP call signaling protocols - IP cablecom - media networking - broadband infrastructure - IP TV - cloud computing - interoperability among multicasting/broadcasting systems - QoS.

Unit IV: Software Methodologies for Converged Networks **9 Hours**

Development of software methodologies for ICT: Software processes in the NGN framework - high level design and analysis methods - enterprise and business modeling notation - object and data definition language - dynamic modeling notations - component and interface notations - distributed systems - creating a unified framework.

Unit V: Activities Based Learning **9 Hours**

Simulation of minimum (four) convergence technologies for various applications using related tools.

Reference Books:

1. Hu Hanrahan, "Network Convergence: Services, Applications, Transport, and Operations Support", John Wiley and Sons, 2007.
2. Jeffrey Bannister, Paul Mather and Sebastian Coope, "Convergence Technologies for 3G Networks", John Wiley and Sons, 2008.
3. David Tung Chong Wong, Peng-Yong Kong, Ying-Chang Liang, KeeChaing Chua and Jon W. Mark, "Wireless Broadband Networks", John Wiley and Sons, 2009.
4. Vijay Garg, "Wireless Network Evolution: 2G to 3G", Prentice Hall of India, 2001.
5. Jyh-Cheng Chen and Tao Zhang, "IP Based Next Generation Wireless Networks - Systems, Architecture and Protocols", John Wiley and Sons, 2003.
6. Guillaume De La Roche, Andres Alayon Glazunov and Ben Allen, "LTE – Advanced and Next Generation Wireless Networks: Channel Modeling and Propagation", John Wiley and Sons, 2013.
7. C. Siva Ram Murthy and B.S. Manoj, "Ad Hoc Wireless Network: Architectures and Protocols", Pearson Education, 2007.
8. Jerry D. Gibson, "Multimedia Communications: Directions and Innovations", Academic Press, 2000.

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2. www.radio-electronics.com/info/telecommunication_networks/
3. http://www.explainthatstuff.com/how-iptv-works.html
4. http://www.computerweekly.com/feature/Converged-networks-The-VoIP-revolution

ECIS 634

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 635	COOPERATIVE COMMUNICATION SYSTEMS	2	1	0	3	45

Prerequisite : Fundamentals of Relay networks and communication systems.

Objective : To provide an intuitive understanding of the practical use of cooperative communications

Outcome : Students will be able to understand the basics of cooperative communication.

Unit I: Introduction **9 Hours**

Cooperative communications - cooperation protocols - hierarchical cooperation; Cooperative Communications with single relay; Multi-node cooperative communications.

Unit II: Distributed Space Time and Space Frequency Coding **9 Hours**

Distributed space-time coding (DSTC); Distributed Space-Frequency Coding (DSFC); Relay selection; Differential modulations for DF cooperative communications - AF cooperative communications.

Unit III: Cooperative Multiple Access and Routing **9 Hours**

Cooperative multiple access - System model; Content-aware cooperative multiple access protocol distributed cooperative routing - network model; cooperation based routing protocol source - channel coding with cooperation.

Unit IV: Broadband Cooperative Communications **9 Hours**

Broadband cooperative communications - system model - cooperative protocol and relay assignment scheme - performance analysis; Network lifetime maximization via cooperation - system models - lifetime maximization by employing a cooperative node - deploying relays to improve device lifetime.

Unit V: Activities Based Learning **9 Hours**

Experimental implementation of relaying platforms - cooperative spatial modulation systems - performance evaluation of cooperative communications with channel coding and modulation techniques using related simulation tools.

Reference Books:

1. Rayliu K J, Sadek A K, Weifeng Su and Kwasinski A, "Cooperative Communications and Networking", Cambridge University Press, 2009.
2. Mischa D and Yonghui Li, "Cooperative Communications: Hardware, Channel and PHY", John Wiley and Sons, 2010.

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1. http://www.springer.com/gp/book/9783642349485
2. https://engagedscholarship.csuohio.edu/cgi/viewcontent.cgi?article=1791&context=etdarchive

ECIS 635

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 636	FREE SPACE OPTICAL NETWORKS	2	1	0	3	45

Prerequisite : Fundamentals of optical communication and networks

Objective : To introduce the concepts of Terabit technology by means of optical wireless communications.

Outcome : Students will be able to design free space optical networks.

Unit I: Introduction **9 Hours**

Propagation of light in unguided media - laser beam characteristics - atmospheric effects on optical signals - coding for atmospheric optical propagation - factors affecting FSO - LOS - LIDAR; Overview of FSO optical transmitters - receivers - subsystems.

Unit II: FSO Transceiver Design and Security **9 Hours**

Light sources: Modulators - photo detectors and receivers - optical amplification - optical signal to noise ratio - acquisition, pointing and tracking - adaptive and active optics - laser safety - node housing and mounting; FSO inherent security levels and layers.

Unit III: Point to Point FSO Systems **9 Hours**

Simple PP design: Transponder nodes - hybrid FSO and RF - FSO point to multipoint - FSO point to mobile; Ring FSO systems: Ring topologies and service protection - ring nodes with add drop - concatenated rings - ring to network connectivity.

Unit IV: Mesh FSO Systems **9 Hours**

FSO Nodes for mesh topology : Hybrid mesh FSO with RF - hybrid FSO fiber networks; WDM Mesh FSO: DWDM and CWDM optical channels - WDM FSO links - WDM mesh FSO networks - service protection in mesh FSO networks.

Unit V: Activities Based Learning **9 Hours**

Simulation of PP FSO system using ring topology / WDM Mesh FSO network with service protection enabled scenario - performance comparison of FSO networks in ring and mesh topology using related tools.

References Books:

1. Stamatios V. Kartalopoulos, “Free Space Optical Networks for Ultra-Broad Band Services”, IEEE Press, 2011.
2. Arun K. Majumdar and Jennifer C. Ricklin, “Free-Space Laser Communications: Principles and Advances”, Springer, 2008.
3. Olivier Bouchet, Herve Sizun, Christian Boisrobert and Frederique De Fornel, “Free-Space Optics: Propagation and Communication”, John Wiley and Sons, 2010.
4. Heinz Willebrand and Baksheesh S. Ghuman, “Free Space Optics: Enabling Optical Connectivity in Today's Networks”, Sams Publishing, 2002.
5. In Keun Son, “Design and Optimization of Free Space Optical Networks”, Dissertations, Electrical Engineering and Computer Engineering, Auburn University, 2010.
6. Fang Liu, “Bootstrapping Free-space Optical Networks”, University of Maryland, 2004.
7. HemaniKaushal, Jain V K, SubratKar, “Free Space Optical Communication”, Optical Networks, Springer, 2017

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2. http://ee.stanford.edu/~jmk/research/fsocom.html
3. http://www.rp-photonics.com/free_space_optical_communications.html

ECIS 636

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 637	GREEN RADIO COMMUNICATION NETWORKS	2	1	0	3	45

Prerequisite : Fundamentals of electronics, communication and wireless networks.

Objective : To impart the importance of reducing energy consumption, CO2 emissions and inculcate green concepts for energy efficient approaches while designing next generation wireless networks.

Outcome : Students can design new green radio architectures and radio techniques to reduce the overall energy consumption.

Unit I: Introduction **9 Hours**

Fundamental tradeoffs on the design of green radio networks: Insight from Shannon's capacity formula - impact of practical constraints - latest research and directions; Algorithms for energy harvesting wireless networks: Energy harvesting technologies - PHY and MAC layer optimization for energy harvesting wireless networks.

Unit II: Green Modulation and Coding **9 Hours**

Modulation: Green modulation and coding schemes in energy constrained wireless networks - energy consumption of uncoded scheme - energy consumption analysis of LT coded modulation.

Unit III: Co-operative Techniques **9 Hours**

Co-operative techniques for energy efficient wireless communications; Energy efficiency metrics for wireless networks - co-operative networks - optimizing the energy efficiency performance of co-operative networks - energy efficiency in co-operative base stations.

Unit IV: Energy Saving Technologies for Green Radio Networks **9 Hours**

Network energy saving technologies for green wireless access networks- cell wilting and blossoming for energy efficiency - dimensioning network deployment and resource management in green mesh networks

Unit V: Activities Based Learning **9 Hours**

Energy consumption analysis of uncoded schemes (M-ary FSK, M-ary QAM) and LT coded modulation schemes.

Reference Books:

1. Ekram Hossain, Vijay K. Bhargava and Gerhard P. Fettweis, "Green Radio Communication Networks", Cambridge University Press, 2012.
2. F. Richard Yu, Yu, Zhang and Victor C. M. Leung ,"Green Communications and Networking", CRC press, 2012.
3. Mazin Al Noor, "Green Radio Communication Networks Applying Radio-Over-Fibre Technology for Wireless Access", Ph. Thesis, Middlesex University, GRIN Publsihing, 2012.
4. Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, "Handbook of Green Information and Communication Systems", Academic Press, 2012.
5. Jinsong Wu, Sundeep Rangan and Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.
6. Mazin Al Noor, "WiMAX Improvements in Green Radio Communications Utilizing Radio-Over- Fiber", GRIN Verlag, 2012.
7. Ramjee Prasad and Shingo Ohmori, Dina Simunic, "Towards Green ICT", River Publishers, 2010.

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1. http://www.comsoc.org/webcasts/view/wireless-green-networking
2. http://home.ku.edu.tr/~nwcl/green.html
3. http://mypage.zju.edu.cn/en/honggangzhang/607861.html
4. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6056686

ECIS 637

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 638	INTERNET OF EVERY THING (IoET)	2	1	0	3	45

Prerequisite : Basics of computer communication networks and wireless sensor networks

Objective : To study the architecture and security principles of Internet of Everything (IoET).

Outcome : Students will be able to design efficient IoET based projects.

Unit I: Introduction **9 Hours**

IoT: Architectural overview - main design principles - standards considerations; M2M and IoT technology fundamentals: devices and gateways - data management - business processes in IoT - everything as a service - M2M and IoT analytics - knowledge management.

Unit II: IoET Sensors **9 Hours**

Sensors for IoE: Wireless sensor structure - energy storage module - power management module - RF Module - sensing module.

Unit III: IoET Security **9 Hours**

Security requirements in IoET architecture - attacks specific to IoET - security in enabling technologies - security concerns in IoET applications; Architecture - insufficient authentication/authorization - insecure access control - threats to access control, privacy and availability.

Unit IV: IoET Testbed **9 Hours**

ACOEM Eagle - EnOcean push button - NEST sensor - Ninja blocks focus on wearable electronics.

Unit V: Activities Based Learning **9 Hours**

Simulation of (minimum of any five) IoE applications - home and office infrastructures - security - home appliances and other IoE electronic equipment- interfacing of sensor with sensor node using any embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino).

Reference Books:

1. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing: Technology, Application and Service Creation", Tata McGraw Hill, 2010.
2. William Stallings, "Data and Computer Communications", 8th Edition, Pearson Education Ltd., 2009.
3. Adelstein F and Gupta S.K.S, "Fundamentals of Mobile and Pervasive Computing", McGraw Hill, 2009.
4. Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010.
5. Arshdeep Bahga and Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015.
6. Manoel Carlos Ramon, "Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers", Apress Media, 2014.
7. Marco Schwartz, "Internet of Things with the Arduino Yun", Packt Publishing, 2014.

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2. https://www.codeproject.com/Learn/IoT/
3. https://www.edureka.co/blog/iot-tutorial/
4. https://www.bbvaopenmind.com/en/the-internet-of-everything-ioe/

ECIS 638

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 639	LOW POWER DIGITAL VLSI DESIGN	2	1	0	3	45

Prerequisite : Fundamentals of VLSI design.

Objective : To understand the low power design methodologies at various design levels from the circuit level to the system level and also power estimation with optimization techniques.

Outcome : Students will be able to design low power VLSI circuits.

Unit I: Power Dissipation **9 Hours**

Introduction: Need for low power circuit design - sources of power consumption - design methodology - low power figure of merits - limits and applications of low power VLSI Design.

Unit II: Power Analysis **9 Hours**

Power analysis: SPICE circuit simulation - discrete transistor modeling and analysis - gate level logic simulation - architecture level analysis - data correlation analysis; Probabilistic power analysis: Random logic signals - probabilistic power analysis techniques - signal entropy.

Unit III: Circuit and Logic Level **9 Hours**

Circuit level: Transistor and gate sizing - equivalent pin ordering - network restructuring and reorganization - special latches and flip flops; Logic level: Gate reorganization - signal gating - logic encoding - precomputation logic; RAM.

Unit IV: Energy Recovery Techniques **9 Hours**

Energy recovery techniques: Energy dissipation using the RC model - energy recovery circuit design - power reduction in clock networks - low power bus - delay balancing.

Unit V: Activities Based Learning **9 Hours**

Simulation study: Sources of power dissipation in SRAMs - low power SRAM circuit techniques; Sources of power dissipation in DRAMs - low power DRAM circuit techniques using related tools.

Reference Books:

1. Kaushik R and Sharat C P, “Low-Power CMOS VLSI Circuit Design”, Wiley Press, 2009.
2. Gary K Y, “Practical Low Power Digital VLSI Design”, Kluwer Academic Publishers, 1998.
3. Bellaouar A and Elmasry M, “Low-Power Digital VLSI Design: Circuits and Systems”, Kluwer Academic Publishers, 1995.
4. Chandrakasan A and Robert W B, “Low-Power CMOS Design”, Wiley-IEEE Press, 1998.
5. Rabaey J M and Massoud P, “Low Power Design Methodologies”, Kluwer Academic Publishers, 1995.
6. Kiat-Seng Y and Kaushik R, “Low-Voltage, Low-Power VLSI Subsystems”, TMH Professional Engineering, 2009.
7. Soudris D, Piguet C and Goutis C, “Designing CMOS Circuits for Low Power”, Kluwer Academic Publishers, 2002.

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1. http://www.nptel.iitm.ac.in/courses/106105034/
2. http://www.eeherald.com/section/design-guide/Low-Power-VLSI-Design.html

ECIS 639

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 640	REAL TIME OPERATING SYSTEM	2	1	0	3	45

Prerequisite : Basics of operating systems and C-Programming.

Objective : To make the students to develop software for embedded computer system using Real-Time Operating System.

Outcome : Students will be able to design real time embedded systems using the concepts of RTOS and also recognize the classification of embedded systems

Unit I: Introduction to Operating Systems **9 Hours**

Basic principles - system calls - files - processes - design and implementation of processes - communication between processes - operating system structures.

Unit II: Distributed Operating Systems **9 Hours**

Topology - network types - communication - RPC - client server model - distributed file system design.

Unit III: Real Time Operating System **9 Hours**

Messages - message queues - semaphore - types of semaphores - priority inversion - priority inheritance - priority ceiling - event based - process based and graph based models - petrinet models - real time languages - RTOS tasks - RT scheduling - interrupt processing – synchronization - control blocks - memory requirements.

Unit IV: RTOS Kernel Topics **9 Hours**

Principles - design issues - polled loop systems - RTOS porting to a target - comparison and study of RTOS VX works and μCOS - dynamic memory allocation - fragmentation issues - RTOS timers - relative and absolute timing - asynchronous signals - device I/O supervisor.

Unit V: Activities Based Learning **9 Hours**

Case Studies on RTOS for image processing - embedded RTOS for voice over IP - RTOS for fault tolerant applications - RTOS for control systems.

Reference Books:

1. Charles C, "Operating Systems-A Design Oriented approach", 1st Edition, McGraw Hill Education, 2017.
2. Krishna C M and Shin K G, "Real Time Systems", 1st Edition, McGraw Hill Education, 2017.
3. Tanenbaum A S, "Distributed Operating Systems", 1st Edition, Pearson Education India, 2002.
4. Raymond A B and Donald L B, "Introduction to Real Time Systems: From Design to Networking with C/C++", Pearson, 1998.

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2. https://www.elprocus.com/real-time-operating-system-rtos-and-how-it-works/
3. https://www.highintegritysystems.com/rtos/what-is-an-rtos/

ECIS 640

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 641	SENSORS AND ACTUATORS	2	1	0	3	45

Prerequisite: Measurements and Instruments.

Objective : To make the students to understand basic laws and phenomena on operation of sensors and actuators-transformation of energy.

Outcome : Students will able to analyze various premises, approaches, procedures and performance related to sensors and actuators.

Unit I: Sensors / Transducers **9 Hours**

Principles - classification - parameters - characteristics - Environmental Parameters (EP) – characterization; Mechanical and Electromechanical Sensors: Introduction - resistive potentiometer- strain gauge - resistance strain gauge - semiconductor strain gauges - inductive sensors: sensitivity and linearity of the sensors; Types of capacitive sensors: Electrostatic transducer - force/stress sensors using quartz resonators - ultrasonic sensors.

Unit II: Thermal Sensors **9 Hours**

Introduction - gas thermometric sensors - thermal expansion type thermometric sensors - acoustic temperature sensor - dielectric constant and refractive index thermosensors - helium low temperature thermometer - nuclear thermometer - magnetic thermometer - resistance change type thermometric sensors - thermo EMF sensors - junction semiconductor types - thermal radiation sensors - quartz crystal thermoelectric sensors - NQR thermometry - spectroscopic thermometry - noise thermometry.

Unit III: Radiation Sensors **9 Hours**

Introduction - basic characteristics - types of photosensistors/photo detectors - x-ray and nuclear radiation sensors - fiber optic sensors; Electro analytical sensors: The electrochemical cell - the cell potential - standard hydrogen electrode (she) - liquid junction and other potentials - polarization - concentration polarization - reference electrodes - sensor electrodes - electro ceramics in gas media.

Unit IV: Actuators **9 Hours**

Pneumatic and hydraulic actuation systems - actuation systems - pneumatic and hydraulic systems - directional control valves - pressure control valves - cylinders - servo and proportional control valves - process control valves - rotary actuators mechanical actuation systems - types of motion - kinematic chains- cams - gears - ratchet and pawl - belt and chain drives- bearings- mechanical aspects of motor selection electrical actuation systems - electrical systems - mechanical switches - solid - state switches solenoids - D.C. motors- A.C. motors- stepper motors.

Unit V: Activities Based Learning **9 Hours**

Design and analysis of sensors and actuators for various applications using related simulation tools.

Reference Books:

1. Patranabis D, "Sensors and Transducers", PHI Learning Private Limited, 2003.
2. Bolton W, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", 5th Edition , Pearson Education Limited, 2013
3. Patranabis D, " Sensors and Actuators", 2nd Edition, PHI, 2013

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2. https://www.elsevier.com/journals/sensors-and-actuators-b:-chemical/0925-4005?generatepdf=true
3. http://www.mlrinstitutions.ac.in/sites/default/files/M.Tech_Digital Systems and Computer Electronics.pdf

ECIS 641

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 642	SOFT COMPUTING	2	1	0	3	45

Prerequisite : Basics of set theory.

Objective : To familiarize the salient approaches in soft computing based on artificial neural networks, fuzzy logic, and genetic algorithms.

Outcome : Students will be able to apply concepts of artificial neural networks, fuzzy logic, and genetic algorithm for real time applications.

Unit I : Neural Network **9 Hours**

Basic concept - mathematical model - properties of neural networks - architectures - different learning methods - common activation functions - application of neural networks; Neuron architecture: Algorithms - McCullo h-Pitts - Back propagation - ADALINE - MADALINE - discrete hopfield net - BAM - Maxnet.

Unit II: Fuzzy Sets & Logic **9 Hours**

Fuzzy versus Crisp - fuzzy sets - fuzzy relations - laws of propositional logic - inference - predicate logic fuzzy logic - quantifiers - inference - defuzzification methods.

Unit III: Genetic Algorithm **9 Hours**

Role of GA - fitness function - selection of initial population - cross over (different types) - mutation - inversion - deletion - constraints handling and applications of travelling salesman and graph coloring.

Unit IV: Hybrid Systems **9 Hours**

Hybrid Systems: GA based BPNN (Weight determination) - neuro fuzzy systems - fuzzy BPNN - fuzzy neuron - architecture - learning - fuzzy logic controlled genetic algorithm.

Unit V: Activities Based Learning **9 Hours**

Simulation of PSO - HSA and ACO related to either wireless networking or antenna or image processing using related tools.

Reference Books:

1. S. N. Sivanandam and S. N. Deepa, "Principles of Soft Computing", 2nd Edition, John Wiley India, 2012.
2. S. Haykin, "Neural Networks - A Comprehensive Foundation", 2nd Edition, Pearson Education, 2005.
3. T. S. Rajasekaran and G. A. VijaylakshmiPai, "Neural Networks, Fuzzy Logic & Genetic Algorithms – Synthesis and Applications", Prentice Hall India, 2003.
4. Sanchez, Takanori and Zadeh, "Genetic Algorithm and Fuzzy Logic System", World Scientific, 1997.
5. Goldberg David, "Genetic Algorithms", Pearson Education, 2006.
6. Zimmermann H J, "Fuzzy Set Theory and its Applications", Allied Publishers Ltd, 1991.
7. Stamatios V. Kartolopoulos, "Understanding neural networks and fuzzy logic: Basic concepts and Applications" , Wiley - IEEE press, 1995.

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2. http://www.cedar.buffalo.edu/~srihari/CSE555/
3. https://www.ibm.com/developerworks/library/cc-beginner-guide-machine-learning-ai-cognitive/index.html

ECIS 642

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECIS 643	VEHICULAR AD-HOC NETWORKS (VANET)	2	1	0	3	45

Prerequisite : Wireless communication and network, and mobile ad-hoc networks

Objective : To introduce the students with the emerging technologies and their standards with applications for vehicular communication systems.

Outcome : Students will able to understand the basic principles, standards, and system architecture of Vehicular Ad-hoc Networks.

Unit I: Introduction **9 Hours**

Basic principles and challenges - past and ongoing VANET activities; Cooperative vehicular safety applications- enabling technologies - DSRC regulations and standard - cooperative system architecture.

Unit II: Vehicular Mobility Models **9 Hours**

Introduction - notation description - random models - flow models - traffic models - behavioral models - trace or survey based models - integration with network simulators - design framework for realistic vehicular mobility models.

Unit III: Routing Protocols **9 Hours**

Routing protocols: Opportunistic packet forwarding - topology based routing - geographic routing – Performance characteristics; Standards: Protocol stack.

Unit IV: Security **9 Hours**

Requirement - challenges - adversaries - VANET supporting properties - message authentication and integrity using Digital Signatures - detection of malicious data and secure position verification.

Unit V: Activities Based Learning **9 Hours**

Simulation of vehicle to vehicle communication - vehicle to infrastructure and infrastructure to vehicle communication using related tools.

Reference Books:

1. Sommer C and Dressler F, "Vehicular Networking", Cambridge University Press, 2015.
2. Emmelmann M, Bochow B and Kellum C. C, "Vehicular Networking: Automotive Applications and Beyond", Wiley, 2010.
3. Watfa M, "Advances in Vehicular Ad-Hoc Networks: Development and Challenges", Information Science Reference, 2010.
4. Moustafa H and Zhang Y, "Vehicular Networks: Techniques, Standards, and Applications", CRC Press, 2009.
5. Hartenstein H and Laberteaux K. P, "VANET: Vehicular Applications and Inter Networking Technologies", Wiley, 2010.

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ECIS 643

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