Annexure '13'

ANNEXURE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SYLLABUS

MASTER OF TECHNOLOGY (M. Tech)

in

Digital Electronics and Communication Engineering

[Effective from 2019 batch]

SIKKIM MANIPAL UNIVERSITY ★ 5th Mile Tadong-Gangtok ★

ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT SMIT Majitar - Rangpo East Sikkim Pin-737132 ★ MAJITAR ★

SMIT SIKKIM MANIPAL UNIVERSITY

SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY

SMIT SIKKIM MANIPAL UNIVERSITY
SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY

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MINUTES OF BOS MEETING HELD AT M.TECH LAB (ROOM NO C402), EC ENGINEERING, SMIT REGARDING THE UPGRADATION OF M.TECH DECE ENGINEERING SYLLABUS

EXTERNAL BOS MEMBER Present :-

1. Prof.(Dr.) Subir Kumar Sarkar – Professor and Ex-HOD, Dept of ETC, Jadavpur University, Kolkata-700032

INTERNAL BOS MEMBER Present:-

1. Prof.(Dr.) Sourav Dhar - Chairman BOS, ECE and HOD, ECE, SMIT
2. Prof.(Dr.) Rabindranath Bera - Professor and Member, BOS, ECE, SMIT
3. Prof.(Dr.) Prashanta Chandra Pradhan - Professor and Member, BOS, ECE, SMIT
4. Dr. Om Prakash Singh - Associate Professor and Member, BOS, ECE, SMIT
5. Dr. Hemanta Saikia- Associate Professor and Member, BOS, ECE, SMIT

The revised M.Tech (DECE) syllabus has been presented to the BOS members by HOD, ECE for open discussion and consideration and approval.

All the members had a detailed look and discussions on the revised syllabus and finally the syllabus has been approved. The revised syllabus will be effective from the academic session 2019 – 20 onwards.

SMIT, MAJHITAR

Date: 10th MAY, 2019

10.05.2019
Prof. (Dr.) Subir Kumar Sarkar

10/5/19
Prof. (Dr.) Sourav Dhar

RBera
Prof. (Dr.) Rabindranath Bera
10.5.2019

10/5/19
Prof. (Dr.) Prashanta Chandra Pradhan

Dr. Om Prakash Singh

10/05/19
Dr. Hemanta Saikia

Note 1: The 2nd External BOS Member Mr. Prasun Kumar Soundra (Principal Architect, Tech MahindraLtd., Kolkata) could not join to the meeting due to his pre-assignment. He was intimated about the entire syllabus through e-mail before the meeting. His e-mail consent will be enclosed.

RE: Syllabus revision of B.Tech (ECE)

Prasun Sounda <PS00433361@TechMahindra.com>

Wed 22-05-2019 22:52

HOD EC <hod.ec@smit.smu.edu.in>;

prasunkr@gmail.com <prasunkr@gmail.com>;

attachments (2 MB)

Modified B.Tech syallbus effective from 2018 Batch (3rd sem 2017 Batch onwards).docx; Modified B.Tech syallbus for 2016-2020 Batch (Only 7th semester).docx; Annexure IV.docx; smime.p7s; ATT00001.txt; ATT00002.htm;

Dr. Dhar,

Thanks for your below mail.

I feel honoured to be part of this syllabus finalization activity.

I, hereby, confirm my alignment with your below suggested revision of the syllabus for your B.Tech (ECE) program. Kindly go ahead with the mentioned revisions in the syllabus.

Look forward to continue this association.

Thanks & Regards,

Prasun Sounda
ROUK-IRL-1 | Tech Mahindra
Mobile: + 44 74598 76036 / +91 98305 06262
Mail: Prasun.Sounda@techmahindra.com

Tech Mahindra

SIKKIM MANIPAL UNIVERSITY * 5th Mile, Tadong *

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Chapter 2: SECOND SEMESTER SYLLABUS

Chapter 3: THIRD AND FOURTH SEMESTER SYLLABUS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CHAPTER S1

M.TECH (DECE) -FULL TIME
TWO-YEAR M.TECH (CGPA SCHEME) DEGREE COURSE

SEMESTER-I

S1.1 FIRST YEAR

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract.	
1	MA 2109	Probability, Statistics and Random Process	Math	3	1	-	3	-	4
2	EC 2101	Information Theory and Coding	EC	3	1	-	3	-	4
3	EC 2102	VLSI Design	EC	3	1	-	3	-	4
4	EC 21**	Elective-I	EC	3	1	-	3	-	4
5	EC 21**	Elective-II	EC	3	1	-	3	-	4
6	EC 2161	VLSI Laboratory	EC	-	-	3	-	3	1.5
7	EC 2162	Communication Laboratory	EC	-	-	3	-	3	1.5
8	EC 2181	Seminar-I	EC	-	-	3	-	-	2
Total credit = 25									

M.TECH (DECE) -FULL TIME
TWO-YEAR M.TECH (CGPA SCHEME) DEGREE COURSE, SEMESTER-II

S1.2 FIRST YEAR

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract.	
1	EC 2201	Internet of Things	EC	3	1	-	3	-	4
2	EC 2202	Statistical Signal Processing	EC	3	1	-	3	-	4
3	EC 22**	Elective-III	EC	3	1	-	3	-	4
4	EC 22**	Elective-IV	EC	3	1	-	3	-	4
5	EC 22**	Elective-V	EC	3	1	-	3	-	4
6	EC 2261	Advanced DSP Laboratory	EC	-	-	3	-	3	1.5
7	EC 2262	IoT Laboratory	EC	-	-	3	-	3	1.5
8	EC 2281	Seminar-II	EC	-	-	3	-	-	2
Total credit = 25									

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M.TECH (DECE) -FULL TIME
TWO-YEAR M.TECH (CGPA SCHEME) DEGREE COURSE

SEMESTER-III & IV

S1.3 SECOND YEAR

Sl. No.	Subject Code	Subject	Teach. Deptt.	Duration of Exam	Credits
1	EC 2375	Dissertation	EC	1. Continuous evaluation to be followed [Candidate has to present PPT quarterly] 2. Final Evaluation with ppt. presentation/demonstration to be followed at the end of session.	35

Total Credits = 25+25+35 = 85

M.TECH (DECE) DISSERTATION EVALUATION SCHEME

Sl. No.	Subject Code	Internal Marks		External Marks	Duration of Project	Credits
		Supervisor Marks	Synopsis and Internal Progress Seminar/Viva			
1	EC 2375	30	20	50	III and IV Semester	35

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M.TECH (DECE) - PART TIME
THREE-YEAR M.TECH (CGPA SCHEME) DEGREE COURSE

SEMESTER-I

S1.4 FIRST YEAR

Sl. No	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec	Tut	Prac	Th	Pract	
1	MA 2109	Probability, Statistics and Random Process	Math	3	1	-	3	-	4
2	EC 2101	Information Theory and Coding	EC	3	1	-	3	-	4
3	EC 2162	Communication Laboratory	EC	-	-	3	-	3	1.5
4	EC 2181	Seminar-I	EC	-	-	3	-	3	2
Total credit = 11.5									

M.TECH (DECE) - PART TIME
THREE-YEAR M.TECH (CGPA SCHEME) DEGREE COURSE

SEMESTER-II

S1.5 FIRST YEAR

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract	
1	EC 2201	Internet of Things	EC	3	1	-	3	-	4
2	EC 2202	Statistical Signal Processing	EC	3	1	-	3	-	4
3	EC 2261	Advanced DSP Laboratory	EC	-	-	3	-	3	1.5
4	EC 2281	Seminar-II	EC	-	-	3	-	3	2
Total credit = 11.5									

M.TECH (DECE) - PART TIME
THREE-YEAR M.TECH (CGPA SCHEME) DEGREE COURSE

SEMESTER-III

S1.6 SECOND YEAR

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract	
1	EC 2102	VLSI Design	EC	3	1	-	3	-	4
2	EC 213*	Elective-I	EC	3	1	-	3	-	4
3	EC 214*	Elective-II	EC	3	1	-	3	-	4
4	EC 2162	VLSI Laboratory	EC	-	-	3	-	3	1.5
Total credit = 13.5									

M.TECH (DECE) - PART TIME
THREE-YEAR M.TECH (CGPA SCHEME) DEGREE COURSE

SEMESTER-IV

S1.7 SECOND YEAR

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract.	
1	EC 223*	Elective-III	EC	3	1	-	3	-	4
2	EC 224*	Elective-IV	EC	3	1	-	3	-	4
3	EC 225*	Elective-V	EC	3	1	-	3	-	4
4	EC 2262	IoT Laboratory	EC	-	-	3	-	3	1.5
Total credit = 13.5									

M.TECH (DECE) - PART TIME
THREE-YEAR M.TECH (CGPA SCHEME) DEGREE COURSE

SEMESTER-V & VI

S1.8 THIRD YEAR

Sl. No.	Subject Code	Subject	Teach. Deptt.	Evaluation Procedure	Credits
1	EC 2375	Dissertation	EC	1. Continuous evaluation to be followed [Candidate has to present PPT quarterly] 2. Final Evaluation with ppt. presentation/demonstration to be followed at the end of session.	35

Total Credits = 11.5+11.5+13.5+13.5+35 = 85

M.TECH (DECE) DISSERTATION EVALUATION SCHEME (PART TIME)

Sl. No.	Subject Code	Internal Marks		External Marks	Duration of Project	Credits
		Supervisor Marks	Synopsis and Internal Progress Seminar/Viva			
1	EC 2375	30	20	50	V and VI Semester	35

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

LIST OF ELECTIVES FOR M.TECH (DECE) - FULL TIME/PART TIME

ELECTIVE-I

Sl. No	Subject Code	Subject
1	EC 2131	Soft Computing Techniques
2	EC 2132	Digital Image Processing
3	EC 2133	Optimization Techniques in Communication
4	EC 2134	Applied Electromagnetics
5	EC 2135	Concepts and Modeling of Semiconductor Devices
6	EC 2136	4G Technologies and beyond

ELECTIVE-II

Sl. No	Subject Code	Subject
1.	EC 2141	Cognitive Radio in 5G
2.	EC 2142	Wireless Sensor Networks
3.	EC 2143	Speech Processing
4.	EC 2144	VLSI Testing
5.	EC 2145	Digital Integrated Circuit Design

ELECTIVE-III

Sl. No	Subject Code	Subject
1.	EC 2231	Machine Learning
2.	EC 2232	Biomedical Signal Processing
3.	EC 2233	Low-Power VLSI Design
4.	EC 2234	Mobile and Adhoc Communication Networks
5.	EC 2235	Computational Electromagnetic

ELECTIVE-IV

Sl. No	Subject Code	Subject
1.	EC 2241	Data Science for Engineers
2.	EC 2242	Cloud Computing
3.	EC 2243	Analog Integrated Circuit Design
4.	EC 2244	Nanomaterials and Nanoelectronic Devices
5.	EC 2245	Cryptography and Network security

ELECTIVE-V

Sl. No	Subject Code	Subject
1.	EC 2251	Software Defined Networks
2.	EC 2252	High Speed Digital Design
3.	EC 2253	VLSI Fabrication Technology
4.	EC 2254	Radar Systems and Signal Processing
5.	EC 2255	Satellite and Optical Communication

Minimum No. of credits to be earned for promotion		
M. Tech Degree (Full Time):		
From	To	Min. credits to be earned
I Year	II Year	30/50
Final	Final	85/85
M. Tech Degree (Part Time):		
I Year	II Year	14/23
II Year	III Year	30/50
Final	Final	85/85
Credits:		
Theory paper		4 each
Lab paper		1.5 each
• Promotion criteria are applicable for year-wise promotion.		

MA 2109 (EC) **(3Th+1T hrs/week)**

Probability, Statistics and Random Process

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Objective: Stochastic processes play a major role in many areas of communication engineering and signal process. This course is designed in such a way that electronics and communication engineers are able to apply the mathematical tools to areas such as random noise and sampling based on observed data.

Pre -requisite: Calculus, Knowledge counting techniques on Linear Algebra.

UNIT-I

Probability

Discrete and continuous random variables, pmf and pdf, probability distribution function for discrete and continuous cases, jointly distributed random variables, discrete and continuous, marginal distributions, discrete and continuous, conditional distributions, discrete and continuous, distribution functions for two dimensional random variables, discrete and continuous, probability distributions for multidimensional random variables, Problems in each case.

Moments of order 'r', discrete and continuous, moment generating functions, characteristic function, Problems. Conditional distribution and conditional expectations, Problems. Regression curves, Least square regression curves, regression lines, Problems. Distributions: Binomial, Poisson, Uniform, Normal, Gamma, exponential, Chi square, t and F-distribution. Transformation of random variables, univariate and bivariate, discrete and continuous, Problems. Reliability, MTTF, inequalities and limit theorems.

UNIT-II

Statistics

Random sampling, Sampling distributions of statistic. Estimation of parameters, Point estimation and interval estimation, Method of maximum likelihood, Application to different populations. Method for finding confidence intervals. problems. Testing of hypothesis, Application to normal population. Partial and multiple correlations, Analysis of variance.

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Stochastic Process

Bernoulli, Poisson and Renewal Process, availability analysis Markov Chains: Continuous parameter and discrete parameter Markov Chains. Concept of queue, the M/M/1, M/M/∞, M/M/c, and M/G/1 queuing system, Network of queues, open and closed queuing network and examples.

Text Books:

1. Trivedi, K. S; Probability, Statistics and queuing - Computer Science Application, Prentice Hall.
2. Veerarajan, T.: Probability, Statistics and Random Process, TMH.
3. Gupta, A.: Groundwork of Mathematical Probability and Statistics, Academic Press
4. Meyer, P.L. : Introductory Probability and Statistical Applications, .Oxford & IBH

References :

1. Ross, S.M.: introduction to probability and statistics for engineers and scientists.
2. William Feller: Introduction to Probability Theory and its Applications, , 2008, Wiley.
3. Geza Schay. Introduction to Probability with Statistical Applications, , 2007, Brikhau
4. Medhi, J. Stochastics Processes, New age International.

EC 2101 **(3Th+1T hrs/week)**

Information Theory and Coding

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: The course is intended to give students a basic idea of information theory and coding. The course offers different types of source and channel coding technique, channel capacity and bounds, probability of error calculation for different channels.

Pre-requisites: Random Process and variable, Probability

UNIT-I

Information and Sources [4 Hrs]
Definition of Information, Properties of Information, Physical interpretation of amount of Information, Zero memory information source, Entropy, Properties of Entropy, Markov information source, Adjoint Source, Extensions of a Markov source

Properties of Codes [2 Hrs]
Uniquely decodable codes, Instantaneous cods, Construction of Instantaneous cods, Kraft's Inequality, McMillan's Inequality

Coding Information Sources [4 Hrs]

The average length of a code, Encoding for the special sources, Shannon's First Theorems, Shannon Fano algorithm, Huffman's Codes, r-array compact cods, code efficiency and redundancy.

Channel and Mutual Information [8 Hrs]

Information Channels, probability relation in a channel, apriori and posteriori entropies, A generalization of Shannon's first theorem, Mutual information, properties of mutual information, noiseless and deterministic channels, cascaded channels, channel capacity, conditional mutual information.

Reliable messages through non reliable channels [5 Hrs]
Error probability and decision rules, The Fano bound, Reliable messages and unreliable channels, An example of coding to correct errors, Hamming distance, Shannon's Second theorem for binary symmetric channel (BSC)-The First step, Random coding-Second Step.

UNIT-II

Introduction to Algebra [2 Hrs]

Groups, Fields, Binary Field Arithmetic, construction of Galois Field GF (2^m) and basic properties of Galois Field GF (2^m)

Introduction to Error Correcting Codes

Linear Block Codes **[4 Hrs]:**
Introduction, Syndrome and Error Detection, Minimum distance of a block code, Error detecting and error correcting capabilities, Standard Array and Syndrome decoding, Hamming code, Reed Muller codes.

Convolutional codes **[8 Hrs]**
Convolutional encoders: Memory order and impulse response, Recursive convolutional encoders, Puncturng, convolutional code trellises, minimum free distance
Decoding convolutional codes: BCJR, Log MAP decoding, and Viterbi decoding

Turbo codes **[3 Hrs]**
Turbo encoders and Iterative turbo decoding

LDPC Codes **[6 Hrs]**
Introduction, Error correction using parity checks, Encoding and Decoding, LDPC Properties and constructions.

Polar Codes [**2 Hrs**]: Introduction to polar codes.

Text Books

1. N. Abrahamson, Information Theory and coding. 2e, McGraw Hill, 1963
2. Thomos M.Cover et.al, Elements of Information Theory. 2e, Wiley Series in Telecommunication, 2004.
3. Sarah J Johnson, Iterative error correction. Cambridge University Press, 2010.

Reference Books:

4. R.G. Gallager, "Information Theory and reliable communication" , Wiely Newyork,1e, 1968
5. Richard E. Blahut, "Principles and practices of information Theory" –, Addison Wesley,1e 1987.
6. David Slapian, "Key papers in the development of information theory" , IEEE press, 1e, 1973.
7. Shu Lin et.al, Error Control coding. 2e, Pearson, 2011.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2102 **(3Th+1T hrs/week)**

V L S I Design

Question to be set : *Eight (Four from each unit). Each question carries 20 marks.*

Questions to be answered : *Any five selecting at least two from each unit.*

Credit : *4 (L-3, T-1, P-0)*

Course Objective: To serve as a basic course in acquiring knowledge in Very Large Scale Integration (VLSI). This course describes impart a solid understanding of the role of embedded systems and embedded systems design and development of NMOS, PMOS and CMOS based circuitry, fabrication techniques, different hardware descriptive language, VLSI design testing and current industrial trends.

Pre-requisites: Analog and Digital Electronics, Semiconductor Physics

UNIT-I

1. **MOS Physics [6 Hrs]**: Two Terminal MOS Structure, Three Terminal MOS Structure: Contacting the inversion layer, Body effect, Regions o f inversion, Pinch-off voltage; Four Terminal MOS Transistor: Transistor regions of operation, general charge sheet models, regions of inversion in terms of terminal voltage, strong inversion, weak inversion, moderate. Inversion, interpolation models, effective mobility, temperature effects, breakdown p-channel MOS FET, enhancement and depletion type, Small dimension effects: channel length modulation, hot carrier effects, scaling, effects of surface and drain series resistance, effects due to thin oxides and high doping. Sub threshold regions.
2. **CMOS Circuit And Logic Design[6 Hrs]:** CMOS Logic Gate Design, Physical Design of Combinational and sequential CMOS circuit design, Designing with Transmission Gates, ,Pass transistors, CPL Dynamic CMOS, NORA logic, DOMINO Logic , Clocking Strategies, I/O Structures.
3. **CMOS Device Design [6 Hrs]**: Scaling, Threshold voltage, MOSFET channel length; CMOS Performance Factors: Basic CMOS circuit elements; parasitic elements; sensitivity o f CMOS delay to device parameters; performance factors of advanced CMOS devices.
4. **Analog VLSI [6 Hrs]:** CMOS Amplifiers & CMOS Operation Amplifiers: Basic concepts, Performance Parameters, One state OPAMP, Two stage OPAMP, Stability and Phase

compensation, Cascade OPAMP, Design of two-stage and Cascade OPAMP, SPICE simulation of Amplifier, High performance CMOS OPAMPs, Micro-power OPAMP,

UNIT-II

5. **Module Generation [6 Hrs]**: Finite State machines, state encoding, parameterized blocks PLA, RAM, ROM generation. Gate Level Synthesis; Binary Decisions Diagrams, Logic minimization, optimization and retargeting.

6. **Layout Synthesis [6 Hrs]**: Placement; simulated annealing, genetic algorithms, constructive methods. Routing; nets, layers, Lees algorithms, cost functions, channel routing. Examples of a channel router with placement expansion

7. **VLSI Design Methods [6 Hrs]:** Language based methods including VHDL/Verilog, hierarchical state machine descriptions such as State Charts and Petri net based methods. Functional languages for formal verification. Modeling of MOS and Bi-MOS devices using SPICE, Verilog HDL-RTL coding and synthesis.

8. **Design for Manufacturability and Testability** [6 **Hrs**]: Process variation, performance modeling, parametric Yield estimation and maximization, worst case analysis, different types of fault and model, different types of testing technique. Recent Trends and Industrial application of VLSI Design.

Textbooks:

1. Sung Mo Kang,YusufLeblebici, CMOS digital integrated circuit ,4th Edition , Tata Mcgraw Hill Education Private Limited, 2018.
2. Ayan Banerjee, Neil H.E. Weste, David Harris, CMOS VLSI design,1e, Tata Mcgraw Hill, 4th Edition ,2017.
3. N. Weste and K. Eshranghian, "Principles of CMOS VLSI Design", Addison Wesley, 1998.

Reference Book:

1. Gary K. Yeap,"Practical Low Power Digital VLSI Design", Kluwer Academic Press, 2002.
2. Jan M. Rabaey,"Digital Integrated Circuits: A Design Perspective", Pearson Education 2006.
3. Jacob Backer, Harry W. Li and David E. Boyce, " CMOS Circuit Design, Layout and Simulation ", Prentice Hall of India 2008.

EC 2131 **(3Th+1T hrs/week)**

Soft Computing Techniques (Elective-I)

Question to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*
Credit *: 4 (L-3, T-1, P-0)*

Course Objective:

1. Understanding of soft computing techniques such as Genetic Algorithms (GA), Fuzzy Logic and Neural Network.
2. Understanding of various optimization Techniques.
3. Ability to take up projects at advanced/professional level.

Pre-requisites: Probability, Linear Algebra.

UNIT – I

1. **Introduction**
Decision problems, Multi-criteria decision analysis, MCDA methods.
2. **Analytic hierarchy process (AHP)**
Multivalued logic, paired comparison, absolute and relative measurements, scale, consistency and Eigen vector, hierarchic synthesis, case studies on decision making using AHP in communication engineering.
3. **Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS):**
Comparison of characteristics between AHP and TOPSIS, The operations within TOPSIS, External aggregation, internal aggregation, TOPSIS method, Comparison of Weights in TOPSIS Models, case studies on decision making using TOPSIS in communication engineering.
4. **Genetic Algorithms (GA)**
Basic concepts of genetic algorithms, encoding, genetic modeling, case studies on decision making using GA in communication engineering.

UNIT- II

5. Fuzzy Logic
Crisp set and Fuzzy set, Basic concepts of fuzzy sets, membership functions. Basic operations on fuzzy sets, Properties of fuzzy sets, Fuzzy relations; Propositional logic and Predicate logic, fuzzy If – Then rules, fuzzy mapping rules and fuzzy implication functions, Applications.

6. Neural Networks

Basic concepts of neural networks, Neural network architectures, Learning methods, Architecture of a back propagation network, Applications.

7. Optimization Techniques

Convex optimization Techniques, Particle Swarn Optimization (PSO), ANT colony optimization and other recent techniques, Support Vector Machines (SVM) and Principal component Analysis (PCA).

Text Book:

1. T.L. Saaty, Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process (Analytic Hierarchy Process Series, Vol. 6), 2e (3rd print), RWS Publication, 2011.

2. A. Ishizaka and P.Nemery, Multi-Criteria Decision Analysis: Methods and Software, 1e, Willey, 2013.

3. Simon Haykin, Neural Networks: A Comprehensive Foundation, 2e. PHI,1998 .

4. S. Rajasekaran and G. A. Vijaylakshmi Pai, Neural networks, fuzzy logic, and genetic algorithms : synthesis and applications, 2e, Prentice Hall of India, 2013.

5. K. H. Lee, First Course on Fuzzy Theory and Applications, 1e, SpringerVerlag,2005.

6. J. Yen and R. Langari, Fuzzy Logic: Intelligence, Control and Information, 2e, Pearson Education,2007

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2132 **(3Th+1T hrs/week)**

Digital Image Processing (Elective-I)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course objective:

To enrich the knowledge of the students with a sound understanding of various techniques of digital image processing. This course will present the fundamentals of image processing, will cover various transforms (e.g., DFT,DCT and DWT), and many applications, such as enhancement, filtering, segmentation, compression (like JPEG) and image recognition.

Pre-requisites: Signals and Systems, Digital Signal Processing

UNIT – I

1. **Digital Image Fundamentals [4 Hrs.]:** Digital image representation. Elements of a digital image processing system, image model, Sampling and quantization .Basic relationships between pixels and imaging geometry.
2. **Image Transforms [8 Hrs.]:** DFT, DCT, DWT.
3. **Image Enhancement [5 Hrs.]:** Spatial and frequency domain methods, image enhancement by histogram modification, Image smoothing, Image sharpening, Enhancement based on image model.
4. **Image filtering and restoration [4 Hrs.]**: Inverse filter, Wiener filter, Restoration based on degradation model, algebraic approach to restoration.

UNIT – II

5. **Image segmentation [6 Hrs.]:** Detection of discontinuities, Edge linking, and boundary detection, Thresholding Region based segmentation.
6. **Image Data Compression [7 Hrs.]:** Pixel coding, Predictive techniques, Transform coding, Vector quantization, JPEG, JPEG 2000
7. **Applications [10 Hrs.]:** Face Recognition, Signature Verification, Iris Recognition, Fingerprint Recognition

Text Books:

1. Rafel C. Gonzalez and Paul Wintz, *Digital Image processing*, 3e, Pearson Education, 2013.

2. Anil K. Jain, *Fundamentals of Digital Image Processing*, 2e, PHI, 2004.

3. William K. Pratt, *Digital Image Processing,* 4e, John Wiley & Sons; 2007.

References:

1. Bhabatosh Chanda andDwijesh DuttaMajumder, *Digital Image Processing and Analysis*, 2e, PHI Learning, 2011.

2. Milan Sonka, Vaclav Hlavac andRoger Boyle, *Image Processing, Analysis and Machine Vision*, 32e, Cengage Learning India Pvt Ltd, 2007.

3. S. Annadurai and R. Shanmugalakshmi, *Fundamentals of Digital Image Processing*, 1e, Pearson Education, 2007

EC 2133 (3Th+1T hrs/week)

Optimization Techniques in Communication (Elective-I)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks*
Questions to be answered	*: Any five selecting at least two from each unit*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: This course is focused on developing the fundamental tools/ techniques in modern optimization as well as illustrating their applications in diverse fields such as Wireless Communication, Signal Processing, Machine Learning and Big Data.

Pre-requisites: Basic knowledge of Calculus, Probability, Matrices

UNIT – I

Mathematical Review [6 Hrs]

Introduction to properties of Vectors spaces and matrices, Transformation, Geometry and calculus.

Unconstrained Optimization [14 Hrs]

Basics of Set-Constrained and Unconstrained Optimization; One-Dimensional Search Methods: Golden Section Search, Fibonacci Search, Newton's Method, Secant Method; Gradient Method; Newton's Method; Conjugate Direction method; Unconstrained Methods and Neural Network; Genetic Algorithm.

UNIT II

Linear Programming [6 Hrs]

Introduction to Linear Programming; Simplex Method; Duality; Non Simplex Methods

Non-Linear Constrained Optimization [10 Hrs]

Problems with Equality Constraints; Problems with Inequality Constraints; Convex Optimization Problems

Application of Optimization Techniques in Communication and Signal Processing [6 Hrs]

Case studies.

Text Books:

1. Edwin K. P. Chong and Stainslaw H. Zak, *An introduction to Optimization*. Fourth Edition, Wiley, 2013
2. Stephen Boyd Department and Lieven Vandenberghe, *Convex Optimization*. Cambridge University Press, 2009
3. L.R. Foulds, *Optimization Techniques: An Introduction*. Springer-Verlag New York Inc, 1981.

Reference Books:

1. V.K. Kapoor, *Operations Research: Techniques for Management*. S Chand, 2001.
2. Godfrey C. Onwubolu and B. V. Babu, *New Optimazation Techniques in Engineering*. Springer-Verlag New York Inc, 2004.
3. Hamdy A. Taha, *Operations Research*. Fifth edition, Macmillan Publishing Company, 2007.
4. Kumar Gupta, Prem and Hira, D.S., *Operations Research*, S Chand & Company Limited, 2008.

EC 2134 **(3Th+1T hrs/week)**

Applied Electromagnetics (Elective-I)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: To serve as an advanced course in acquiring knowledge of electromagnetic Theory along with its applications in various fields.

Pre-requisites: Basics of Electro-statics and Magneto-statics, Vector algebra, Vector Calculus and Coordinate system

UNIT-I

1. **Electromagnetic Theory**

Introduction to Microwave Engineering, Maxwell's Equations, Fields in Media and Boundary Conditions , The Wave Equation and Basic Plane Wave Solutions, General Plane Wave Solutions, Energy and Power, Plane Wave Reflection from a Media Interface, Oblique Incidence at a Dielectric Interface, Some useful Theorems.

2. **Transmission Line Theory**

The Lumped-Element Circuit Model for a Transmission Line, Field Analysis of Transmission Lines, The Terminated Lossless Transmission Line, The Smith Chart, The Quarter-Wave Transformer, Lossy Transmission Lines

3. **Transmission Lines and Waveguide**

General Solutions for TEM, TE, and TM Wave, Parallel Plate Waveguide, Rectangular Waveguide, Circular Waveguide, Coaxial Line, Surface Waves on a Grounded Dielectric Slab, Microstrip Line, Wave Velocities and Dispersion.

UNIT-2

4. **Antennas for Wireless Communication:**

Microstrip antenna & Dielectric Resonator Antenna – Basic Characteristics, Feeding Methods, Method of analysis, Transmission line model and cavity model for rectangular patch antenna, Circular Patch Antenna, Inverted F Antenna, Planar Spiral Antenna.

5. **Smart Antenna:**

Introduction, Benefits of Smart Antennas, Structures for Beamforming Systems, Strategies for the coverage and Capacity Improvement, Smart Antenna Algorithms

6. **Remote Sensing:**

Radar and Satellite Systems, Overview of remote sensing, Atmospheric radiation basics, EM spectrum, Emission, Absorption, Scattering, Radiative transfer equation, Reflection and refraction, Rayleigh and Mie scattering

Text Books:

1. D.M. Pozar, Microwave Engineering, 1e, John Wiley & Sons, 2005
2. Roger F. Harrington, Time Harmonic Electromagnetic Fields, 1e, McGraw Hill, 1961.
3. A. Balanis, Antenna Theory: Analysis and Design, 2e, John Wiley, 2005.,
4. Luk and Leung, Dielectric Resonator Antenna, 1e, Research Studies Press, 2002.
5. T. K. Sarkar, Smart Antenna, 1e, Wiley, 2003.
6. G.P. De Loor, Radar Remote Sensing, 1e, Harwood Academic, 1983.

EC 2135 **(3Th+1T hrs/week)**

Concept and Modeling of Semiconductor Devices (Elective-I)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: The course aims at providing introduction to different concepts and models applicable to semiconductor devices. It aims at elementary classical and quantum aspects of electron theory. Focuses on the various models related to band structure concepts, fermi surfaces, and semi-classical theory of transport. Relaxation-time approximation, surface effects and defects in crystals are introduced.

Pre-requisites: Basic concept of semiconductor device physics

UNIT – I

Theory of Metals [6Hrs]: Basic assumptions of the model; Collision or relaxation times; DC electrical conductivity; Hall Effect and magnetoresistance; AC electrical conductivity; Thermal conductivity; Thermoelectric effect.

Measuring the Fermi surface [4Hrs]: Free electron Landau levels; Bloch electrons Landau levels; Effects of electron spin; Anomalous skin effect; Size effect.

Fermi Dirac distribution; Ground state energy and bulk modulus; Thermal properties of a free electron gas; Hall effect and magnetoresistance.

Electron levels in a periodic potential [7Hrs]: The periodic potential and Bloch's theorem; The fermi surface; Density of levels and Van Hove Singularities; Perturbation theory and weak periodic potentials; fermi surface and Brillouin Zones; Spin orbit coupling.

The tight binding method [3Hrs]: Linear combinations of atomic orbitals; General features of tight binding levels; Wannier functions.

UNIT – II

The semi-classical theory [6Hrs]: The relaxation time approximation; General form of the non-equilibrium distribution function; DC electrical conductivity; AC electrical conductivity; thermal conductivity; Thermoelectric effects; Conductivity in magnetic field.

Relaxation time approximation and Surface effects [6Hrs]: Sources of electronic scattering; Scattering probability and relaxation time; general description of collisions; The Boltzmann equation. The Hartree equations; The Hartree-Fock equations.
Surface effects: Work function; Contact potential; Thermionic emission.

Dielectric properties of insulator [3Hrs]: Macroscopic electrostatic Maxwell equations; Covalent insulators, Pyroelectric and ferroelectric crystals

Defects in crystals [5Hrs]: Thermodynamics of point defects, Achottky and Frenkel defects, Annealing, Electrical conductivity of Ionic crystals, Polarons and Excitons; Dislocations, Stacking Faults and Grain boundaries

Text Books:

1. Neil W. Ashcroft, N. David Mermin, "Solid state physics", 2nd edition, Thomson, 2007.
2. S. M Sze and Kwok. K. Ng., "*Physics of Semiconductor Devices*" 3rd edition, Willey, 2008.
3. Yuan Taur and Tak. H. Ning "*Fundamental of modern VLSI devices*" 1st edition, Cambridge university press, 1998.

Reference Books:

1. Ben Streetman and Sanjay Banerjee, *Solid State Electronic Devices*, 7e, Prentice-Hall, 2015.
2. Donald A. Neamen, *Semiconductor Physics And Devices: Basic Principles*, 4e, Tata McGraw-Hill Pvt. Ltd., 2012.

EC 2136 **(3Th+1T hrs/week)**

4G Technologies and Beyond (Elective-I)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: To serve as an advanced course in acquiring knowledge in wireless Communication. This course describes fundamentals of wireless propagation channel, Cellular Concept and overview of different Cellular system. This course offers basic understanding of 4G mobile communication.

Pre-requisites: Digital communication, wireless communication, Probability and random processes

UNIT-I

Generic Technologies of Mobile Communication

1. Modulation Techniques used in Wireless Systems: BPSK, DPSK, QPSK, Offset QPSK, $\pi/4$ QPSK, $\pi/4$-DQPSK, MSK, GMSK, GFSK, QAM, and OFDM.

2. Introduction to Mobile Communication Systems :
   Evolution of mobile communication systems, FDMA/TDMA/CDMA/OFDMA/SC-FDMA, FDD/TDD, Overview of MIMO. Carrier Aggregation. VoLTE.

3. Cellular Concept and Mobile Radio Propagation
   Basic Concepts, Frequency reuse, Channel assignments, handoff, Trunking and Grade of Service, Improving coverage and system capacity

4. Introduction and basic properties of radio wave propagation, Outdoor and Indoor propagation models, Small scale Multipath propagation and measurements, fading.

5. Overview of Cellular systems- AMPS, GSM, WCDMA/HSPA, CDMA2000, LTE, LTE-A and WiMAX.

6. High Data Rates in Mobile Communication, high data rates: fundamental constraints, higher data rates within a limited bandwidth:
   higher-order modulation, wider bandwidth including multi-carrier transmission,

UNIT-II

4G LTE/LTE-Advanced for Mobile Broadband

1. LTE radio access - an overview, Radio interface architecture-an overview

2. Physical transmission resources. Overall Time–Frequency Structure, Normal Subframes and Mbsfn Subframes, Carrier Aggregation, Duplex Schemes

3. Downlink physical-layer processing.. Transport-Channel Processing, Downlink Reference Signals, Multi-Antenna Transmission, Downlink L1/L2 Control Signaling

4. Uplink physical-layer processing.. transport-channel processing, uplink reference signals, uplink multi-antenna transmission, uplink l1/l2 control signaling.

5. Retransmission protocols, hybrid ARQ with soft combining, radio-link control.

6. **Application of LTE:** Introduction to Voice Over LTE (VoLTE) , Testing VoLTE Phones, Test Bed for verifying LTE-A Carrier aggregation, Integrate a Flexible R&D Test bed for LTE.

Text Books:

1.Theodore S. Rappaport, Wireless Communications: Principles and Practice, 2e, Pearson, 2010.
2. William C.Y.Lee, Mobile Cellular Telecommunication, 2e, McGraw Hill International Edition, 1995.
3. E. Dahlman, S. Parkvall, and J. Skold, 4G LTE/LTE-Advanced for Mobile Broadband, 2e, Elsevier, 2011.

Reference books:

1. Jochen Schiller, Mobile Communication, 2e, Pearson Education, 2009.
2. Moray Rumney, LTE and the Evolution to 4G Wireless Design and Measurement Challenges, 2e, Agilent Technologies Publication, 2009.
3. 3GPP Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding (Release 10), **3GPP TS 36.212** v10.0.0 (2010-12) http://www.3gpp.org/ftp/Specs/html-info/36-series.htm.3GPP
4. Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures (Release 10), **3GPP TS 36.213** v10.0.0 (2010-12).
5. http://literature.cdn.keysight.com/litweb/pdf/5992-1074EN.pdf?id=2647225
6. https://en.wikipedia.org/wiki/Voice_over_LTE
7. http://literature.cdn.keysight.com/litweb/pdf/5992-0149EN.pdf?id=2523327
8. http://literature.cdn.keysight.com/litweb/pdf/5992-0486EN.pdf?id=2585468
9. https://www.youtube.com/watch?v=s2eMpAxPtg8&feature=youtu.be
10. https://www.youtube.com/watch?v=n8bMOG8s5ug&feature=youtu.be
11. http://literature.cdn.keysight.com/litweb/pdf/5990-6202EN.pdf?id=1933967

EC 2141 **(3Th+1T hrs/week)**

Cognitive Radio in 5G (Electives -II)

Question to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : *Any five, selecting at least two from each unit.*
Credit : *4 (L-3, T-1, P-0)*

Course Objective:

1. To serve as a beginner course in acquiring knowledge in Cognitive Radio to be utilized in 5th Generation Mobile Communication system.

The Unit I of the course describes Fundamental Issues in Cognitive Radio, Radio-Scene Analysis, Stochastic Approach for Spectral Estimation, Extraction of Channel-State Information, Information Theoretic Analysis of Cognitive Radio Systems, Coexistence and Spectrum Sharing, Basic Cognition Cycle, Protocol Suite for Cognitive Radios in Dynamic Spectrum Access Networks, OFDM FBMC based Cognitive Radios for Dynamic Spectrum Access Networks, Opportunistic Spectrum Access Strategy.

The Unit II of the course describes the application of Cognitive radio in 5G Mobile System.

2. The Cumulative Knowledge of UNIT I and UNIT II is thus aiming for further progress in research as well as ample Job opportunities in the field of Electronics and Communication Engineering.

Pre-requisites:

- Review of Probability and Random Process
- Knowledge of Signals and Systems, DSP and Adaptive Signal Processing
- Introduction to Information Theory, definition of information, Information sources, Measure of information, Entropy, Information rate, Shannon's Theorem and Channel capacity
- Knowledge of MIMO based antenna
- Introduction to Mobile Communication Systems & RADAR, Overview of MIMO

UNIT-I

1. **Cognitive radio overview**
   Spectrum sensing: Noise floor, dynamic range and interference rejection; Frequency resolution and sensing window; Sensing latency; Simultaneous spectrum monitoring and communication.
   Spectrum decision, Spectrum sharing, Spectrum mobility.

2. **FBMC as cognitive radio physical layer**
   Spectral selectivity and dynamic range, Spectral efficiency, Spectrum monitoring in FBMC, Spectrum sensing method: Energy detection, Cyclostationarity detection, Other sensing methods.

3. **FBMC and OFDM spectral efficiency comparison**
   Out-of-band radiation analysis - (i) CP-OFDM based spectrum pooling systems, (ii) RC-OFDM based spectrum pooling systems, (iii) IOTA/OQAM based spectrum pooling systems, (iv) PHYDYAS/OQAM based spectrum pooling systems, Spectral efficiency analysis, Simulation results.

4. **RF impairments at the transmitter**
   Cognitive radio background, State of the art of WIMAX OFDM transmitter, Test scenario for cognitive radio, Baseband simulation parameters, Non linearity of a power amplifier, IQ imbalance, Phase noise, Joint effect of the three imperfections.

5. Decentralized dynamic spectrum allocation in uncoordinated cognitive radio networks based on adaptive antenna array interference mitigation diversity, System model and problem formulation, IM-based DSA algorithms - (i) "Selfish" IM-based DSA algorithm, (ii) "Good Neighbor" threshold-regulated IM-based DSA algorithm, Power control for IM-based DSA algorithms, Mixed "good neighbor"/"selfish" IM-based DSA networks, Simulation results - (i) Stationary horizontal CR scenarios without pathloss and shadowing, (ii) Stationary horizontal CR scenarios with pathloss and shadowing, (iii) Non stationary vertical CR scenarios.

UNIT-II

6. **5G Waveform:**
   Introduction to Filter Bank Multi Carrier (FBMC) Technology, Comparison between FBMC & OFDM. FBMC Transmitter: Generation of Zadoff-Chu sequences used as preamble in 5G transmitter, Efficient DFT of Zadoff-Chu sequences in an FBMC source, FBMC OQAM Modulator, FBMC Poly Phase Network based IFFT, FBMC Extended IFFT. FBMC Receiver: Fractional Frequency Estimator, FBMC Frame Synchronizer, FBMC Frame De-multiplexer, OQAM Demodulator, FBMC Channel Equalization and Phase Tracking.

7. **Antenna Beamformation in 5G Mobile Communication System:**
Cooperative Switched and Adaptive Receiver Beam forming in 5G, Adaptive Weights estimation in ADBF Receiver.
Implementation of 73.5 GHz 5G prototype system using RF Beam formation, Least Square Channel Estimator & Fast computation Decision Feedback Equalizer in Receiver RF Beam former of 5G communication system.
Hybrid Beam forming technique for mm Wave 5G communication systems.

8. **Applications of Cognitive Radio in 5G:**
A generic Test Bed for Compensation of rain attenuation using frequency agile cognitive approach.
Channel Capacity improvement through Heterogeneous Network Technology in 5G Mobile Communication System.

Text Book:

1. Ekram Hossain and Vijay Bhargava, Cognitive Wireless Communication Networks, Sringer, 1e, 2007.
2. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, 5G Mobile and Wireless Communications Technology, Cambridge University Press, 1e, 2016
3. http://www.ict-phydyas.org/delivrables/PHYDYAS-D8-1-part1.pdf/at_download/file
4. http://www.ict-phydyas.org/delivrables/PHYDYAS-D8-2.pdf/view
5. http://www.ict-phydyas.org/delivrables/Phydyas-D8-3.pdf/view
6. B.M. Popovic, Efficient DFT of Zadoff-Chu sequences, ELECTRONICS LETTERS, 1st April 2010, Vol. 46 No. 7.
7. http://www.keysight.com/upload/cmc_upload/All/Modeling_4G_and_5G_Systems_in_SystemVue.pdf

8. Tinith Pitakandage, Milos Milosavljevic, Pandelis Kourtessis, and John M. Senior, Cooperative 5G Switched and Adaptive Receiver Beamforming for Fibre Wireless Networks, ICTON 2014 We.A4.2, 978-1-4799-5601-2/14/©2014 IEEE.

Reference Book:

1. Tilde Fusco, Angelo Petrella and Mario Tanda, Data-aided symbol timing and CFO synchronization for filter bank multicarrier systems, IEEE Transaction, Wireless Communication, Vol. 8, pp. 2705-2715, May 2009.
2. S. Beyme and C. Leung, Efficient computation of DFT of Zadoff-Chu sequences, IEEE Electronics Letters, Vol. 45 No. 79, 23rd April, 2009.
3. Tero Ihalainen, Tobias Hidalgo Stitz, Mika Rinne and Markku Renfors, Channel equalization in filter bank based multicarrier modulation for wireless communications, EURASIP Journal on Advances in Signal Processing, Vol. 2007.
4. http://www.ict-phydyas.org/teamspace/internal-folder/FBMC-Primer_06-2010.pdf
5. http://www.kics.or.kr/Home/UserContents/20140415/140415_133223287.pdf
6. 5GNOW, "5G Waveform Candidate Selection D3.1," 2013.

7. http://www.ict-phydyas.org/delivrables/PHYDYAS-D5-1.pdf
8. Mark Cudak, Tom Kovarik, Timothy A. Thomas, Amitava Ghosh, Yashihisa Kishiyama, Takehiro Nakamura, Experimental mmWave 5G Cellular System, 2014 IEEE Globecom Workshops (GC Wkshps), 2014, pp. 377 - 381, ISSN : 2166-0077.
9. Timothy A. Thomas, Huan Cong Nguyen, Dept. of Electronic Systems, Aalborg University Nokia, George R. MacCartney Jr., Theodore S. Rappaport NYU WIRELESS, 3D mmWave Channel Model Proposal, 2014 IEEE 80th Vehicular Technology Conference (VTC2014-Fall), 2014, pp. 1 - 6, ISSN : 1090-3038.

EC 2142 **(3Th+1T hrs/week)**

Wireless Sensor Network (Electives -II)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five, selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: To understand and explore wireless sensor networks and its applications for human kind.

Pre-requisites: Students should have previous knowledge of transducers, communication engineering and computer networks.

UNIT-I

Module-I: Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, general Applications of Sensor Networks. [4 Hrs.]

Module-II: Comparison of Mobile Adhoc Networks (MANETs), Vehicular Adhoc Networks (VANET) and Wireless Sensor Networks (WSN), Enabling technologies for Wireless Sensor Networks. [4Hrs.]

Module-III: Sensor Node Hardware and Network Architecture, Single-node architecture, Hardware components and design constraints, Operating systems and execution environments, introduction to TinyOS and nesC, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts. [10 Hrs.]

UNIT-II

Module-IV: Deployment and Configuration, Localization and positioning, Coverage and connectivity, Single-hop and multihop localization, self-configuring localization systems, sensor management, Handover in WSN. [6Hrs.]

Module-V: Network Protocols, Issues in designing MAC protocol for WSNs, IEEE 802.15.4 standard and Zig Bee, Dissemination protocol for large sensor network, Routing protocols for WSN. [6Hrs.]

Module-VI: Role of WSN in IoT, WSN for Habitat Monitoring, Environment Monitoring, Mine safety and monitoring, smart agriculture, Industrial WSN, Green WSN. [6Hrs.]

Text Books :

1. Holger Kerl, Andreas Willig, *Protocols and Architectures for Wireless Sensor Network*, John Wiley and Sons, 2005, ISBN: 978-0-470-09511-9

2. Raghavendra, Cauligi S, Sivalingam, Krishna M., ZantiTaieb, *Wireless Sensor Network*, Springer,1e, 2004, ISBN: 978-4020-7883-5.

3. Waltenegus Dargie, Christian Poellabauer, *Fundamentals of Wireless Sensor Networks: Theory and Practice*, Willey, 2010, ISBN 978-0-470-99765-9.

Reference Books:

1. Ibrahiem M. M. El Emary, S. Ramakrishnan, *Wireless Sensor Networks: From Theory to Applications*, CRC Press, 2016, ISBN 9781138198821

2.Kazem, Sohraby, Daniel Minoli, TaiebZanti, *Wireless Sensor Network: Technology, Protocols and Application*, John Wiley and Sons,1e, 2007 ,ISBN: 978-0-471-74300-2.

EC 2143 **(3Th+1T hrs/week)**

Speech Processing (Elective II)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five, selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: To enrich the knowledge of the students with a sound understanding of various techniques of speech processing. It begins with the human speech production mechanism and then goes on to the fundamental parameters of speech such as pitch frequency, formants, spectral features like log spectrum, 3-D spectrogram, cepstral features, MFCC, linear prediction coefficients, transform-domain parameters, etc. It deals with applications like speech coding, speech enhancement, speaker and language recognition, speech recognition, text to speech synthesis, and the overview of state of the art techniques like DNN for speech processing.

Pre-requisites: Signal and System, Digital Signal Processing, Probability and Random Process.

UNIT- I

1. **Introduction to Speech Processing** [10 Hrs.]

   Human Speech production mechanism and its digital model, Place and Manner of Articulation, Windowing, Pre-emphasis filter, STFT, Spectrogram. Auditory perception: psycho acoustics

2. **Feature Extraction** [12 Hrs.]

   Prosodic features:-Energy contour, Pitch contour, and Syllable duration, Voiced /Unvoiced detection using Energy and Zero crossing Rate, AMDF and Pitch.

   Acoustic features:- LPC- Basic Principles of linear predictive analysis, Auto correlation method, Solution of LPC equations using Durbin's Recursive algorithm, Cepstral analysis of Speech, MFCC, Shifted Delta Cepstral.

UNIT – II

3. **Statistical Modeling Techniques** [8 Hrs.]

   K-means clustering and Vector quantization, Gaussian mixture Modeling, Hidden Markov modeling, Dynamic time warping, GMM mean supervector, Joint factor analysis (JFA), i-vector.

4. **Channel Compensation Techniques [2 Hrs]:** Joint factor analysis (JFA), Linear Discriminant Analysis (LDA), Within-class covariance normalization (WCCN), Nuisance Attribute Projection (NAP)
5. **Classifiers [3 Hrs]**: Cosine distance scoring, Support vector machine, Gaussian PLDA, Generative Gaussian model, Logistic regression, Deep Neural network (DNN)
6. **Application of speech processing** [12 Hrs.]

   Speech Coding (LPC Vocoder, CELP), Speech Enhancement, Speaker and Language recognition, Automatic Speech Recognition, Text to Speech Synthesis

Text Books:

1. Thomas F, Quatieri, Discrete-Time Speech Signal Processing, Prentice Hall Pearson Education,2004.
2. Douglas O'Shaughnessy, Speech communication: human and machine, Addison-Wesley Pub.Co.,1987
3. L.R. Rabiner and B. H. Juang, Fundamentals of Speech Recognition, Prentice Hall,1993.

Reference Books:

1. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc., Singapore, 2004
2. L.R.Rabiner and R.W.Schaffer – Digital Processing of Speech signals – Prentice Hall - 1979
3. J.R. Deller, J.H.L. Hansen and J.G. Proakis, Discrete Time Processing of Speech Signals, John Wiley, IEEE Press, 1999.

EC 2144 (3Th+1T hrs/week)

VLSI Testing (Elective II)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: Apply the concepts in testing which can help them design a better yield in IC design. Tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs. Analyze the various test generation methods for static & dynamic CMOS circuit.

Pre-requisites: Basic knowledge in MOS , Digital and analog VLSI design .

UNIT-I

1. **Introduction to Testing**: Role of testing VLSI circuits, VLSI trends affecting testing, Physical Faults, Stuck-at Faults, Stuck open Faults, Permanent, Intermittent and Pattern Sensitive Faults, Delay Faults.
2. **Fault Modeling**- Functional Testing, Structural Testing, Types of Fault Models, Stuck-at Faults, Bridging Faults, cross point faults, Fault Equivalence, Fault Dominance
3. **Fault Simulation**- Design Verification, Modeling Levels and Types of Simulators, True value simulation algorithm - Compiled-Code, Event-Driven; Fault Simulation algorithm-Serial, Parallel, Deductive and Concurrent Fault Simulation.
4. **Testability Measure** – Controllability, Observability, SCOAP measures for combinational and sequential circuits

UNIT-II

5. **ATPG for Combinational Circuits**: Path Sensitization Methods, Roth's D- Algorithm, PODEM Algorithm, Complexity of Sequential ATPG, Time Frame Expansion
6. **Design for Testability**- Ad-hoc, Structured DFT- Scan method, Scan Design Rules, Overheads of Scan Design, Built In Self Test- System level Diagnosis, LFSR, Exhaustive, pseudorandom test pattern Generation, BILBO, Pseudo-Random Pattern Generation, Weighted Pseudo-Random Pattern Generation, response compaction - Parity

checking, Ones counting, Transition Count, Boundary Scan Standard - TAP Controller, Test Instructions

7. **Concept of Redundancy**, Spatial Redundancy, Time Redundancy, Error Correction codes, Reconfiguration Techniques, Yield Modeling Reliability.
8. **Universal test sets**: Pseudo-exhaustive and iterative logic array testing. Clocking schemes for delay fault testing. Testability classifications for path delay faults. Test generation and fault simulation for path and gate delay faults.

Textbooks:

1. Michael L.Bushnell, Vishwani D. Agrawal, "Essentials of Electronic Testing for Digital Memory & Mixed Signal VLSI Circuits", Kluwer Academic Publications, 2015.
2. Michael L. Bushnell &Vishwani D. Agrawal," Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits", Kluwar Academic Publishers. 2010.
3. Sung-Mo Kang, Yusuf Leblebici CMOS Digital Integrated Circuits – Analysis and Design , TMH, 2017.
4. Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, " Digital Systems Testing and Testable Design", 3rd Edition, Jaico Publishing House, 2014

Reference Book:

1. Hideo Fujiwara, " Logical testing & design for testability", The MIT Press, 4th Edition,2015.
2. N. Jha& S.D. Gupta, "Testing of Digital Systems", Cambridge, 2013.
3. W. W. Wen, "VLSI Test Principles and Architectures Design for Testability", Morgan Kaufmann Publishers. 2016.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2145 **(3Th+1T hrs/week)**

Digital Integrated Circuit Design (Elective II)

Questions to be set	*: Eight (Four from each unit).Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Objectives: This course deals with the design of various digital integrated circuit used in VLSI technology. All detailed basics required are covered.

Pre-requisites: Basic knowledge in digital electronics circuit and linear & nonlinear device and circuits.

UNIT-I

1. The CMOS Inverters and CMOS Logic Gates – the Static View: Introduction to CMOS Inverter, The Static CMOS Inverter – An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter, Introduction to Static CMOS Design, Complementary CMOS, Rationed Logic, Pass-Transistor Logic.

2. CMOS Inverter – the Dynamic View: Performance of CMOS Inverter: The Dynamic Behavior, Power, Energy, and Energy-Delay, Perspective: Technology Scaling and its Impact on the Inverter Metrics

3. Dynamic CMOS Logic, Timing Metrics: Dynamic CMOS Design, CMOS Logic Design Perspectives, And Timing Metrics: Timing Metrics for Sequential Circuits, Classification of Memory Elements.

4. Static and Dynamic Sequential Circuits: Static Latches and Registers, Dynamic Latches and Registers, Alternative Register Styles: Pulse Registers and Sense-Amplifier Based Registers, Pipelining: An Approach to Optimize Sequential Circuits – Latch Vs Register-Based Pipelines and NORA-CMOS – A Logic Style for Pipelined Structures, Non-bistable Sequential Circuits.

UNIT-II

5. Coping with Interconnect: Introduction, Capacitive Parasitic, Resistive Parasitic, Inductive Parasitic, Advanced Interconnect Techniques, Networks-on-a-Chip.

6.Timing Issues in Digital Circuits: Introduction, Timing Classification of Digital Systems, Synchronous Design – An In-depth Perspective, Self-Timed Circuit Design, Synchronizers and Arbiters, Clock Synthesis and Synchronization Using a Phase-Locked Loop, Future Directions and Perspectives

7.Designing Arithmetic Building Blocks: Introduction, Data paths in Digital Processor Architecture, The Adder, The Multiplier, The Shifter, Other Arithmetic Operators, Power and Speed Trade-off's in Data path Structures, Perspective: Design as a Trade-off .

8.Designing Memory and Array Structures: Introduction, The Memory Core, Memory Peripheral Circuitry, Memory Reliability and Yield, Power Dissipation in Memories, Case Studies in Memory Design: The PLA, A 4-Mbit SRAM and A 1-Gbit NAND Flash memory, Perspective: Semiconductor Memory Trends and Evolution.

Textbooks:

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits – A Design Perspective, 2nd edn., Pearson Education, 2003. ISBN: 8178089912.
2. K. Eshraghian, and N.H.E. Weste, Principles of CMOS VLSI Design – a Systems Perspective, 2nd edn., Addison Wesley, 1993.
3.Wayne Wolf, Modern VLSI Design System – on – Chip Design, 3rd edn., Pearson Education, 2003.

Refinances Books:

1. M. Michael Vai, VLSI Design, CRC Press, 2001.
2. John P. Uyemura, CMOS Logic Circuit Design, Springer (Kluwer Academic Publishers), 2001.
3. Ken Martin, Digital Integrated Circuit Design, Oxford University Press, 2000.

EC 2161 **(3 Hrs/Week)**

VLSI Laboratory

Credit : 1.5 (0L+0T+3P hrs/week)

Minimum No. of Experiments to be carried out: 12.

Course objective : To familiarize the students with the basics of VLSI Design and VERILOG Programming Language. Students will be able to design

1) The VLSI circuitry, layout design and floor planning using Mentor-graphics software.
2) The digital electronics circuitry, able to write Verilog code and implementation on FPGA Board.

Pre-requisites: VERILOG, Digital Electronics, VLSI.

List of Experiments:

Verilog HDL-RTL design , synthesis and implementation on FPGA

1. Design and Write Verilog code for different combinational circuit and implement it into FPG board.
2. Design and Write Verilog code for D, T, and J/K flip-flops and implement it into FPG board.
3. Design Asynchronous MOD 8 up counter using T- flip flop by EDA tools and implement it into FPG board.
4. Design and write verilog codes for 4 bit register by using EDA tools and implement it into FPG board.
5. Design RTL schematic of 64 bit MIPS RISC processor by using EDA tools.

Process technology

6. Cleaning of p-type & n-type Si-wafer by solvent method & RCA cleaning
7. Metallization & Schottky diode fabrication
8. Characterization of metal semiconductor contact.
9. Fabrication of MOS capacitor

Layout design technology

10. Familiarization with any layout tools & Design rules(Example : MENTOR HEP1)
11. Implement logic circuit for AND function and perform its DC and Transient analysis.
12. Implement CMOS logic circuit for any Boolean function and perform its DC and Transient analysis.
13. Draw and simulate MUX using AND/OR/INVERT gates in schematic editor

14. Design layout of a two input CMOS basic gate using any equivalent layout tool. Use any standard Design rules
15. Design and simulate layout of a CMOS Ex-or gate using any equivalent layout tool. Use any standard Design rules
16. Using CAD TOOL, draw the layout of a simple CMOS full adder circuit using TG logic.
17. Familiarization with SPICE CMOS Model parameters.
18. MOS and Bi-MOS design by SPICE Model

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2162 **(3 Hrs/Week)**

Communication Laboratory

Credit : 1.5 (0L+0T+3P hrs/week)

Minimum No. of Experiments to be carried out: 12. [Minimum experiments to be done from group1, 2, 3 and 4 are 3, 2, 2 and 3, respectively.]

Course Objective: To familiarize the students with the characteristic of the wireless channel, equalizer system, OFDM, MIMO concept. Students will be able to implement some of the standard communication system and able to do performance analysis of the system.

Pre-requisites: Analog and Digital Communication.

List of Experiments:

Group-1

1. Study of BER Vs. SNR curves and constellation diagram for QPSK, QAM modulation.
2. Design LMS and RLS based adaptive equalizer and study its BER Vs. SNR performance.
3. Design ZF, MMSE and ML receiver and study its BER Vs. SNR performance.
4. Write a programme for CRC encoder followed by its detection at the receiver side.
5. Design convolution encoder and Viterbi decoder and study its BER Vs. SNR performance.
6. Write a programme for plotting the probability distribution function for the Rician, Rayleigh and Nakagami-m Channel. And its impact on the transmitted signal.
7. Design of OFDM based communication system and study its BER Vs. SNR performance.
8. Study of BER Vs. SNR curves for MIMO communication system.

Group-2

9. Study the performance of WiFi System.
10. Study the performance of WiMax System.
11. Study the performance of LTE System.
12. Study the performance of 5G communication System.

Group-3

13. Analog and Digital communication link using optical fiber.
14. Study of Propagation loss, Bending loss and Measurement of Numerical Aperture in OFC.

Group-4

15. Hardware realization of the basic communication system using LabVIEW.
16. Realization of correlation processing in SFF SDR platform.
17. Hardware realization of DTH system.
18. Satellite searching by aligning DTH system and its analysis.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2201 **(3Th+1T hrs/week)**

Internet of Things (IoT)

Question to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : *Any five selecting at least two from each unit.*
Credit : *4 (L-3, T-1, P-0)*

Course Objectives:

The course is designed to provide an introduction to the Internet of Things (IoT) for postgraduate students who already have a background in electronic engineering or a related subject, an understanding of basic networking, wireless communication.

To understand the basics of Internet of Things.
To get an idea of some of the application areas where Internet of Things can be applied.
To understand the middleware for Internet of Things.
To understand the IOT protocols.

On completion of this course, understand where the IoT concept fits within the broader ICT industry and possible future trends. Understand the various network protocols used in IoT. Be familiar with the key wireless technologies used in IoT systems, such as WiFi, 6LoWPAN, Bluetooth and ZigBee. After completion, students will be in a position for designing and analyzing the IOT systems which has high market demand.

Pre-requisites:

Students should have previous knowledge of basic networking, wireless communication.

UNIT-I

1. **Introduction to the Internet of Things (IoT)**

   What is the Internet of Things (IoT)?, Definitions and Functional Requirements , Motivation ,Architecture, Web 3.0 View of IoT, Ubiquitous IoT Applications , Four Pillars of IoT, DNA of IoT, The Toolkit Approach for End-user Participation in the Internet of Things. Middleware for IoT: Overview , Communication middleware for IoT , IoT Information Security, Typical IoT applications, Trends and implications

2. **IoT Architectures**

   Architectures for IoT, Elements of an IoT Architecture, Architectural design considerations, Wireless Communication Standards for the Internet of Things

3. **IoT Network protocols (MAC layer)**

   Protocol Standardization for IoT, TCP/IP Stack and IP smart Objects Protocols, M2M and WSN Protocols, Wireless sensor networks (WSNs) and power consumption, CSMA/CA and slotting, Centralized vs. distributed, State-of-the-art MAC-layer protocols for WSNs, Protocols – IEEE 802.15.4.

UNIT-II

4. **Wireless technologies for IoT (Layer 1 & 2)**
   Wireless SoC (system on chip), RFID, NFC, WiFi (IEEE 802.11), Bluetooth Smart, ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, LTE, Satellite based IoT.

5. **IoT Application**
   Indoor Location - Traffic Congestion - Environments - Resource Management in the Internet of - Smart Grid - Smart Cities – Intelligent transportation system

Text Books:

1. Karl, Holger, and Andreas Willig. Protocols and architectures for wireless sensor networks, 2e, John Wiley & Sons, 2007.
2. Honbo Zhou The Internet of Things in the Cloud: A Middleware Perspective, 1e, CRC Press, 2012.
3. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things , Key applications, and Protocols", 1e, Wiley, 2012.
4. Dharma P. Agrawal, Qing-An Zeng, Introduction to Wireless and Mobile Systems, 4e, Cengage Learning, 2014.

Reference:

1. http://postscapes.com/internet-of-things-protocols
2. http://www.rfwireless-world.com/Tutorials/IoT-tutorial.html
3. http://www.ayecka.com/solutions.php#IOT
4. GreenPeak White Paper-Wireless Communication Standards for the Internet of Things,By Cees Links, CEO GreenPeak Technologies, GreenPeak Technologies , www.greenpeak.com.
5. http://literature.cdn.keysight.com/litweb/pdf/5992-1478EN.pdf?id=2723259

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2202 **(3Th+1T hrs/week)**

Statistical Signal Processing

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objectives:

The objective of this course is to provide a broad and coherent treatment of statistical signal processing concepts, techniques and algorithms, namely for discrete-time signal modeling, optimum estimation and filtering, and power spectrum estimation. These tools are general for applications dealing with information extraction in scenarios governed by random processes and probabilistic models.

Pre-requisites: Signal Processing, Random variables and Random Process

UNIT-I

Review of random variables [8 Hrs]

Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonality principle in estimation, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and autocovariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter, .Random signal modelling: MA(q), AR(p) , ARMA(p,q) models.

Parameter Estimation Theory [8 Hrs]

Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties ; Baysean estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation.

Estimation of signal in presence of white Gaussian Noise [8Hrs]

Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Noncausal IIR Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.

UNIT-II

Adaptive Filtering [8 Hrs]

Principle and Application, Steepest Descent Algorithm, Convergence characteristics; LMS algorithm, convergence, excess mean square error, Normalized LMS algorithm; Application of Adaptive filters; RLS algorithm, derivation, Matrix inversion Lemma, Initialization.

Kalman filtering [8Hrs]

State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter.

Spectral analysis [8Hrs]

Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Prametric method, AR(p) spectral estimation and detection of Harmonic signals, MUSIC algorithm.

TEXT BOOKS

1. Charles W. Therrien, *Discrete Random Signals and Statistical Signal Processing*. Prentice Hall Signal Processing Series, 1992.

REFERENCE BOOK

1. M. H. Hayes, *Statistical Digital Signal Processing and Modeling*. John Wiley & Sons, Inc., 1996.
2. D.G. Manolakis, V.K. Ingle and S.M. Kogon: *Statistical and Adaptive Signal Processing*, McGraw Hill, 2000.
3. J. G. Proakis et. al., *Algorithms for Statistical Signal Processing*, Pearson Education, 2002.
4. Simon Haykin: *Adaptive Filter Theory*, Prentice Hall, 1996.

SIMULATION TEXT BOOKS

1. Monson Hayes, Statistical Digital Signal Processing and Modeling, John Wiley & Sons, Inc.,
2. Chonavel, T, Statistical Signal Processing Modeling and Estimation, Springer 2001.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2231 **(3Th+1T hrs/week)**

Machine Learning (Elective III)

Questions to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : *Any five selecting at least two from each unit.*
Credit : *4 (L-3, T-1, P-0)*

Course Objective: The objective of this course is to provide a concise introduction to the fundamental concepts in machine learning and popular machine learning algorithms. The standard and most popular supervised learning algorithms including linear regression, logistic regression, support vector machines and neural networks with an introduction to Deep Learning. The basic clustering algorithms and feature reduction methods will also be discussed.

Course Outcomes : This will equip the students to apply the machine learning techniques in various domains like speech signal processing, Image and Video Processing, Communications, etc

Pre-requisites: Probability and Random Process, Linear Algebra, and Optimization Techniques.

UNIT – I

Introduction

Basic Definition, Types of Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Examples of Machine Learning Applications.

Linear Regression

Linear Regression with Single Variables- Model Representation and Cost Function, Parameter Learning : Gradient Descent, Gradient Descent Intuition, Gradient Descent For Linear Regression

Linear Regression with Multiple Variables- Multiple Features, Gradient Descent for Multiple Variables, Gradient Descent in Practice: Feature Scaling and Learning Rate, Features and Polynomial Regression, Computing Parameters Analytically: Normal Equations, Normal Equations Noninvertibilty

Logistic Regression

Classification and Representation- Classification, Hypothesis Representation and Decision Boundary

Logistic Regression Model - Cost Function, Simplified Cost Function and Gradient Descent

Multiclass Classification- One-vs-all

Regularization

Solving the problem of Overfitting- The Problem of Overfitting, Cost Function, Regularized Linear Regression, Regularized Logistic Regression.

Support vector Machines

Support vector machines, Kernel functions, and Kernel SVM

Dimensionality Reduction

Principle component Analysis, Factor Analysis and Linear Discriminant Analysis.

Clustering

K-means, Gaussian mixture model, Expectation-Maximization Algorithm

UNIT II

Decision Tree and Ensemble Learning

Introduction, Univariate trees, Pruning, Rule extraction from trees, Learning rules from data, Multivariate trees

Overview of Ensemble methods, Types of Ensemble Methods: Bagging, Boosting , Stacking Random Forest

Neural Networks

Overview of neural networks, Perceptrons, Activation functions, Multilayer network, backpropagation Algorithm,

Introduction to Deep neural network- Deep learning architectures: Restricted Boltzmann machine, Deep belief network, Autoencoder, Feed forward neural network, Time delay neural network (TDNN), Recurrent Neural Network (RNN), Long short-term Memory (LSTM), Gated Recurrent unit (GRU), Convolutional neural networks (CNN), CNN Architectures (AlexNet, VGG, GoogLeNet, ResNet, etc.), Optimization Algorithms (SGD and ADAM).

Applying Machine learning in practice

Deciding What to Try Next, Evaluating a Hypothesis, Model Selection and Train/Validation/Test Sets, Diagnosing Bias vs. Variance, Regularization and Bias/Variance, Learning Curves, Deciding What to Do Next Revisited.

Machine Learning System Design

Prioritizing What to Work On, Error Analysis, Error Metrics for Skewed Classes, Trading Off Precision and Recall, Data For Machine Learning

Large Scale Machine Learning

Learning With Large Datasets, Mini-Batch Gradient Descent, Stochastic Gradient Descent Convergence, Online Learning, Map Reduce and Data Parallelism.

Text Books:

1. Ethem Alpaydın, " *Introduction to Machine Learning*", 2nd Edition, MIT Press, 2010.
2. Tom M. Mitchell, *"Machine Learning "*, McGraw-Hill Science, 1997.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville "Deep Learning", *MIT Press, 2017*

Reference Books:

1. Christopher M. Bishop, *"Pattern Recognition And Machine Learning"*, Springer 2006
2. Stephen Marsland, *"Machine Learning: An Algorithmic Perspective"*, 2nd Edition, CRC Press, 2015.
3. R. O. Duda, P. E. Hart, and D. G. Stork, *"Pattern classification"*. John Wiley & Sons, 2012.

Journal Papers:

[1] F. Musumeci *et al.*, "An overview on application of machine learning techniques in optical network," *in IEEE Communications Surveys & Tutorials*. Dec. 2018.
URL: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8527529

[2] C. Zhang, P. Patras and H. Haddadi, " Deep learning in mobile and wireless networking: A survey ," *in IEEE Communications Surveys & Tutorials*. March. 2019.
URL: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8666641

[3] Deng, L., "A tutorial survey of architectures, algorithms, and applications for deep learning," *APSIPA Transactions on Signal and Information Processing*, vol. 3, e2, pp.1-29, 2014.

[4] Weibo Liu, et al., "A survey of deep neural network architectures and their applications," *Neurocomputing*, vol. 234, 2017, pp. 11-26.
URL: https://www.sciencedirect.com/science/article/pii/S0925231216315533

[5] Litjens, Geert, et al. "A survey on deep learning in medical image analysis " *Medical image analysis*, vol. 42, 2017, pp 60-88.
URL: https://www.sciencedirect.com/science/article/pii/S1361841517301135

[6] Qingchen Zhang, Laurence T. Yang, Zhikui Chen, Peng Li, "A survey on deep learning for big data," *Information Fusion*, vol. 42, 2018, pp. 146-157.
URL: shttps://www.sciencedirect.com/science/article/pii/S1566253517305328

[7] M. Mohammadi, A. Al-Fuqaha, S. Sorour and M. Guizani, "Deep learning for IoT big data and streaming analytics: A Survey, " in *IEEE Communications Surveys & Tutorials*, vol. 20, no. 4, pp. 2923-2960, 2018.

[8] V. Sze, Y. Chen, T. Yang and J. S. Emer, "Efficient processing of deep neural networks: A Tutorial and Survey," in *Proceedings of the IEEE*, vol. 105, no. 12, pp. 2295-2329, Dec. 2017.

[9] F. Richardson, D. Reynolds and N. Dehak, "Deep Neural Network Approaches to Speaker and Language Recognition," in *IEEE Signal Processing Letters*, vol. 22, no. 10, pp. 1671-1675, Oct. 2015.

EC 2232 **(3Th+1T hrs/week)**

Biomedical Signal Processing (Elective III)

Question to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : *Any five selecting at least two from each unit.*
Credit : *4 (L-3, T-1, P-0)*

Course Objective: To make the students learn about Physiology & Human Nervous System, Electro-Physiological Measurements, Non-Electrical Parameter Measurement, Assistive Restorative and Medical Imaging Equipments, Filtering, Event Detection, Waveform Analysis and Frequency-domain Analysis.

Pre-requisites: Basic knowledge in biology and different signals.

UNIT-I

1. **Physiology & Human Nervous System**: Cell, Bioelectricity, Sodium Potassium pump, Action and Resting potentials, Bioelectric Signals, Nervous System, Peripheral Nervous System, Autonomic Nervous System, SNS, PNS.
2. **Electro-Physiological Measurements**: Basic components of biomedical electronics system, Electrodes: Micro, Needle and Surface electrodes, Electrical activity of heart, Generation and Recording of ECG signals, ECG Waves and Time Intervals, Heart Rhythms, Heart beat morphologies, Noise and artifacts, Respiratory system, EEG, EEG Rhythms and waveforms, Recording.
3. Non-Electrical Parameter Measurement: Blood pressure measurement, Cardiac output, Heart Sounds, Respiratory rate, Gas volume, Flow rate, ph value, ESR, GSR, Plethysmography.
4. Assistive Restorative and Medical Imaging Equipments: Phonocardiography, Vectrocardiography, Defibrillators, Pacemakers, X-Ray, Ultrasonography, Computer Tomography, MRI.

UNIT-II

5. **Filtering** : Removal of artifacts contd. Time domain filtering (Moving Average Filter to Integration, Derivative-based operator), Frequency Domain Filtering (Notch Filter),

Removal of artifacts contd. Optimal Filtering: The Weiner Filter, Removal of artifacts contd. Adaptive Filtering Selecting Appropriate Filter,

6. **Event Detection** : P, QRS and T wave in ECG, Derivative based Approaches for QRS Detection Pan Tompkins Algorithm for QRS Detection. Detection contd. Dicrotic Notch Detection Correlation Analysis of EEG Signal.
7. **Waveform Analysis** Illustrations of problem with case studies Morphological Analysis of ECG Correlation coefficient The Minimum phase correspondent and Signal Length. Envelop Extraction Amplitude demodulation The Envelogram Analysis of activity Root Mean Square value Zero-crossing rate Turns Count, Form factor.
8. **Frequency-domain Analysis** :Periodogram. Averaged Periodogram Blackman-Tukey Spectral Estimator Daniellâ€™s Spectral Estimator Measures derived from PSD

Textbooks:

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology" 4th edition, Pearson Education India, 2001.
2. Leslie Cromwell, Fred J, Weibell and Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements" Prentice Hall of India Pvt. Ltd, New Delhi.
3. John G. Webster (Ed.), "Medical Instrumentation Application & Design" 3rd Edition, Wiley India.
4. Reddy D C. "Modern Biomedical Signal Processing – Principles and Techniques", TMH, New Delhi, 2005
5. Akay M. "Biomedical Signal Processing", Academic press, California,1994.

Reference Book:

1. Khandpur R S, "Handbook on Biomedical Instrumentation" TMH, 13th Reprint, New Delhi.
2. Barbara Christe, "Introduction to Biomedical Instrumentation: The Technology of Patient Care" Cambridge University Press 2009 .

EC 2233 **(3Th+1T hrs/week)**

Low power VLSI Design (Elective III)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: Acquire the knowledge about various CMOS fabrication process and its modeling infer about the second order effects of MOS transistor characteristics. Analyze and implement various CMOS low voltage and low power static logic circuits. learn the design of various CMOS low voltage and low power dynamic logic circuits. design and implementation of various structures for low power applications.

Pre-requisites: Basic knowledge in MOS , Digital and analog vlsi design , power calculation.

UNIT-I

1. **Introduction:** Need for low power VLSI chips, Sources of power dissipation in Digital Integrated circuits. Emerging low power approaches. Physics of power dissipation in CMOS devices.
2. **Device & Technology Impact on Low Power**: Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation
3. **Power Estimation**: Simulation Power analysis- SPICE circuit simulators, Gate level logic simulation, Capacitive power estimation, Static state power, Gate level capacitance estimation, Architecture level analysis, Data correlation analysis in DSP systems. Monte Carlo simulation. Probabilistic power analysisRandom logic signals, Probability & frequency, Probabilistic power analysis techniques.
4. **Low Power Design**: Circuit level- Power consumption in circuits, Flip Flops & Latches design, High capacitance nodes, Low power digital cells library Logic level- Gate reorganization, Signal gating, Logic encoding, State machine encoding, Precomputation logic

UNIT-II

5. **Low Power Architecture & Systems**: Power & performance management, Switching activity reduction, Parallel architecture with voltage reduction, Flow graph transformation, Low power arithmetic components, Low power memory design.
6. **Low Power Clock Distribution**: Power dissipation in clock distribution, single driver vs distributed buffers, zero skew vs tolerable skew, chip & package co design of clock network.
7. **Algorithm & Architectural Level Methodologies**: Introduction, design flow, algorithmic level analysis & optimization, architectural level estimation & synthesis.
8. **Recent Trends and Industrial application of Low power VLSI Design:** new power saving design,3D power scaling and industry standard real time project.

Textbooks:

1. Kaushik Roy, Sharat Prasad, Low-Power CMOS VLSI Circuit Design, Wiley, 2016.
2. Sung-Mo Kang, Yusuf Leblebici CMOS Digital Integrated Circuits – Analysis and Design , TMH, 2017.
3. J.Rabaey, "Low Power Design Essentials (Integrated Circuits and Systems)", Springer, 2016
4. J.B.Kuo&J.H.Lou, "Low-voltage CMOS VLSI Circuits", Wiley, 20009.

Reference Book:

1. Rabaey and Pedram, Low power design methodologies, Kluwer Academic,2007.
2. Siva G. Narendran, Anatha Chandrakasan, Leakage in Nanometer CMOS Technologies, Springer, 2015.
3. Michael Keating etal. "Low Power Methodology Manual For System-on-Chip Design" Springer, 2008.
4. A.Bellaowar& M.I.Elmasry,"Low power Digital VLSI Design, Circuits and Systems", Kluwer,2006.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2234 **(3Th+1T hrs/week)**

Mobile and Adhoc Communication Networks (Elective III)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective:
This course will give an idea of Ad-Hoc Wireless Networks, and wireless sensor networks. It will provide some description of Different types of AdHoc Routing Protocols and TCP over AdHoc Protocol. And also provide in-depth knowledge about Sensor Network Architecture, its Applications and MAC Protocols for sensor networks, Localization – Indoor and Sensor Network Localization, and mesh networks.

Pre-requisites: Wireless communication, computer networks.

UNIT – I

1. **Introduction [8 Hrs.]**
   Fundamentals of wireless communication technology – the electromagnetic spectrum – radio propagation mechanisms – characteristics of the wireless channel -mobile ad hoc networks (MANETS) and wireless sensor networks (WSNs): concepts and architectures. Applications of ad hoc and sensor networks. Design challenges in ad hoc and sensor networks.

2. **MAC PROTOCOLS FOR AD HOC WIRELESS NETWORKS [7Hrs.]**
   Issues in designing a MAC Protocol- Classification of MAC Protocols- Contention based protocols Contention based protocols with Reservation Mechanisms- Contention based protocols with Scheduling Mechanisms – Multi channel MAC-IEEE 802.11

   Issues in Ad-Hoc Wireless Networks. MAC Protocols – Issues, Classifications of MAC protocols, Multi-channel MAC & Power control MAC protocol.

3. **AD-HOC NETWORK ROUTING & TCP [8 Hrs.]**
   Issues – Classifications of routing protocols – Hierarchical and Power aware. Multicast routing – Classifications, Tree based, Mesh based. Ad Hoc Transport Layer Issues. TCP Over Ad Hoc – Feedback based, TCP with explicit link, TCP-Bus, Ad Hoc TCP, and Split TCP.

UNIT – II

4. **Wireless Sensor Networks-MAC [8 Hrs.]**
Single node architecture: hardware and software components of a sensor node - WSN Network architecture: typical network architectures-data relaying and aggregation strategies -MAC layer protocols: self-organizing, Hybrid TDMA/FDMA and CSMA based MAC- IEEE 802.15.4.

5. **WSN ROUTING, LOCALIZATION [8 Hrs.]**

Issues in WSN routing – OLSR- Localization – Indoor and Sensor Network Localization-absolute and relative localization, triangulation-QOS in WSN-Energy Efficient Design-Synchronization-Transport Layer issues.

6. **MESH NETWORKS [8Hrs]**

Necessity for Mesh Networks – MAC enhancements – IEEE 802.11s Architecture – Opportunistic routing – Self configuration and Auto configuration – Capacity Models – Fairness – Heterogeneous Mesh Networks – Vehicular Mesh Networks.

Text Books

1. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols ",Prentice Hall Professional Technical Reference, 2008.
2. C.K.Toh, "Ad Hoc Mobile Wireless Networks", Pearson Education, 2002.

Reference Books

1. Carlos De Morais Cordeiro, Dharma Prakash Agrawal "Ad Hoc & Sensor Networks: Theory and Applications", World Scientific Publishing Company, 2006.
2. Feng Zhao and Leonides Guibas, "Wireless Sensor Networks", Elsevier Publication - 2002.
3. Holger Karl and Andreas Willig "Protocols and Architectures for Wireless Sensor Networks",Wiley, 2005

EC 2235 **(3Th+1T hrs/week)**

Computational Electromagnetics (Elective III)

Question to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : *Any five selecting at least two from each unit.*
Credit : *4 (L-3, T-1, P-0)*

Course Objective: The objective of this course is to provide hands-on experience with contemporary numerical approaches in electromagnetics (EM) to student researchers for applications in RF-microwave circuits, high-speed interconnects, MEMS, antenna analysis and design.

Pre-requisites: Electromagnetic Theory

UNIT – I

Fundamental Concepts:

Introduction, Review of Electromagnetic Theory: Electrostatic Fields, Magnetostatic Fields, Time-varying Fields, Boundary Conditions, Wave Equations, Time-varying Potentials, Time-harmonic Fields, Classification of EM Problems: Classification of Solution Regions, Classification of Differential Equations.

Finite Difference Methods:

Finite Difference Schemes, Finite Differencing of Parabolic PDEs, Finite Differencing of Hyperbolic PDEs, Finite Differencing of Elliptic PDEs: Band Matrix Method, Iterative Methods, Accuracy and Stability of FD Solutions, Practical Applications I — Guided Structures: Transmission Lines, Waveguides, Practical Applications II — Wave Scattering (FDTD): Yee's Finite Difference Algorithm, Accuracy and Stability, Lattice Truncation Conditions, Initial Fields, Absorbing Boundary Conditions for FDTD, Finite Differencing for Nonrectangular Systems: Cylindrical Coordinates, Spherical Coordinates.

Variational Methods:

Operators in Linear Spaces, Calculus of Variations, Construction of Functionals from PDEs, Rayleigh-Ritz Method, Weighted Residual Method: Collocation Method, Subdomain Method, Galerkin Method, Least Squares Method, Eigenvalue Problems, Practical Applications.

UNIT-II

Moment Methods:

Integral Equations: Classification of Integral Equations, Connection Between Differential and Integral Equations, Green's Functions: For Free Space, For Domain with Conducting Boundaries, Applications I — Quasi-Static Problems, Application II — Scattering Problems: Scattering by Conducting Cylinder, Scattering by an Arbitrary Array of Parallel Wires, Applications III — Radiation Problems: Hallen's Integral Equation, Pocklington's Integral Equation, Expansion and Weighting Functions, Applications IV — EM Absorption in the Human Body: Derivation of Integral Equations, Transformation to Matrix Equation (Discretization), Evaluation of Matrix Elements, Solution of the Matrix Equation.

Finite Element Method:

Solution of Laplace's Equation: Finite Element Discretization, Element Governing Equations, Assembling of All Elements, Solving the Resulting Equations, Solution of Poisson's Equation: Deriving Element-governing Equations, Solving the Resulting Equations, Solution of the Wave Equation,Automatic Mesh Generation I — Rectangular Domains,Automatic Mesh Generation II — Arbitrary Domains: Definition of Blocks, Subdivision of Each Block, Connection of Individual Blocks,Bandwidth Reduction, Higher Order Elements: Pascal Triangle, Local Coordinates, Shape Functions, Fundamental Matrices, Three-Dimensional Elements,Finite Element Methods for Exterior Problems: Infinite Element Method, Boundary Element Method, Absorbing Boundary Conditions.

Text Books:

Sadiku, Matthew NO. "*Numerical techniques in electromagnetics*". CRC press, 2000.

Reference Books:

Bondeson, Anders, Thomas Rylander, and Pär Ingelström. "*Computational electromagnetics*". Vol. 51. Springer Science & Business Media, 2005.

Sheng, Xin-Qing, and Wei Song. "*Essentials of computational electromagnetics*".Vol. 757.John Wiley & Sons, 2011.

EC 2241 **(3Th+1T hrs/week)**

Data Science for Engineers (Elective IV)

Question to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : *Any five selecting at least two from each unit.*
Credit : *4 (L-3, T-1, P-0)*

Course Objectives:

1. To Provide Insights about the Roles of a Data Scientist and enable to analyze the Big Data.
2. ToUnderstand the principles of Data Science for the data analysis and learn cutting edge tools and techniques for data analysis.
3. Figure Out Machine Learning Algorithms.
4. Learn business decision making and Data Visualization

Pre-requisites: Fundamentals of linear algebra, basic programming skills.

UNIT – I

1. Review of Linear Algebra

Linear algebra for data science, solving linear equations, Distance, Hyper planes and half spaces, Eigen values and Eigen vectors.

2. An Introduction to Data Science

Definition, working, benefits and uses of Data Science, Data science vs BI, The data science process, Role of a Data Scientist

3. Statistical Data Analysis &Inference

Populations and samples, Statistical modeling, probability distributions, fittings a model, Statistical methods for evaluation, Exploratory Data Analysis, Hypotheses testing, Getting started with R programming.

UNIT – II

4. Learning Algorithms

k-nearest neighbor, Simple and multiple Linear Regression, Logistic Regression, Support vector machine, Model-Based Clustering, Clustering High-Dimensional data, Naïve Bayes, Data Wrangling.

5. Data Visualization

Data Visualization basics, techniques, types, applications, tools, Data Journalism, Interactive dashboards

6. Business problems and data science solutions

Data Science and Business Strategy: Thinking Data Analytically, Redux, Competitive Advantage with Data Science, Data Science Case Studies, Case Study: Global Innovation Network and Analysis

Text Books:

1. Rachel Schutt and Cathy O'Neil, *Doing Data Science*, 1/e, O'Reilly Media, 2013
2. Joel Grus ,*Data Science from Scratch*, 2/e, O'Reilly Media, 2015
3. Foster Provost and Tom Fawcett, O'Reilly,*Data Science for Business*,1/e, O'Reilly Media, 2013

Reference Books:

1. Gilbert Strang , *Introduction to Linear Algebra*, 5/e, Wellesley-Cambridge Press and SIAM, 2016
2. Douglas Montgomery, *Applied Statistics and Probability for Engineers*, 3/e, John Wiley & Sons, Inc., 2003

EC 2242 **(3Th+1T hrs/week)**

Cloud Computing (Elective IV)

Question to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : *Any five selecting at least two from each unit.*
Credit : *4 (L-3, T-1, P-0)*

Course objectives: This course gives an introduction to cloud computing and its techniques - Infrastructure as a Service (IaaS), Platform-as-a-Service (PaaS), Software as a Service (SaaS), issues, ecosystem and case studies.

Pre-requisites: Basic knowledge of Computer Network.

Learning outcomes: On successful completion of this module, learners will be able to

1. Evaluate a Software as a Service (SaaS), Platform as a service (PaaS), Infrastructure as a service (IaaS) applications.
2. Analyse the Service Oriented Architecture and Cloud Computing paradigms.
3. Analyse the enterprise models in cloud computing
4. Analyse the Security issues associated with the Cloud Computing paradigm.

UNIT–I

Understanding Cloud Computing
History of cloud computing, Cloud architecture, Cloud storage, need for cloud computing, Advantages of cloud computing, Limitations of cloud computing, Open Source and Commercial Clouds, Cloud Simulator.

Cloud Service Management
Web-based application, Pros and cons of cloud service development, Types of cloud service development, Software as a service (SaaS), Platform as a service (PaaS), Infrastructure as a service (IaaS), Web services, On demand computing, Discovering cloud services, Development services and tools, Amazon Ec2, Google app engine, IBM clouds.

Cloud Data Management and Resource Management
Large-scale data centers. Basic ideas and principles in data center design. Virtualized Cloud data centers. (That reduces operational costs) provides required Quality of Service (QoS). Resource virtualization multiple examples from Xen and VMware. Architectural principles for energy-efficient management of Clouds. Energy-efficient resource allocation policies and scheduling algorithms considering (QoS) expectations and power usage characteristics of the devices. Open research challenges, addressing which can bring substantial benefits to both resource providers and consumers.

UNIT-II

Cloud Security
Federation in the cloud, Presence in the cloud, Privacy and its relation to cloud-based information systems, Security in the cloud, Common standards in the cloud, End-user access to the cloud computing.

Cloud from Business perspective
Software utility applications, Cost versus value, Software application services framework, Common enablers, and Conceptual view to reality, Business profits, implementing database systems for multitenant architecture.

Cloud Computing from users' perspective
Centralizing email communications, Collaborating on schedules, Collaborating on To-Do Lists, Collaborating contact lists, Cloud computing for the community, Collaborating on group projects and events, Cloud computing for the corporation.

Cloud Computing towards IoT
Fog computing, Edge Computing, Mist Computing.

Text Books:

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley,2011
2. Michael Miller, "Cloud computing: Web based applications that change the way you work and collaborate online", Pearson.
3. Haley Beard, "Cloud computing best practices for managing and measuring processes for on demand computing, Applications and data centers in the cloud with SLAs", Emereo.
4. Gautam Shroff, "Enterprise Cloud Computing - Technology, Architecture, Applications", Cambridge University Press, 2010

Reference Books:

1. Guy Bunker and Darren Thomson, "Delivering Utility Computing", John Wiley & Sons.
2. George Reese, "Cloud Application Architectures", O'Reilly.
3. Lee Gillam, "Cloud Computing: Principles, Systems and Applications", Springer.
4. Brian J. S. Chee, Curtis Franklin, Jr., "Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center", CRC Press.
5. Ronald L. Krutz, Russell Dean Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley- India,2010
6. Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2243 **(3Th+1T hrs/week)**

Analog Integrated Circuit Design (Elective IV)

Question to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : *Any five selecting at least two from each unit.*
Credit : *4 (L-3, T-1, P-0)*

Course Objectives: This course deals with design of analog integrated circuits with emphasis on the design of feedback circuits at the transistor level.

Pre-requisites: Concept of analog electronics and VLSI circuit.

UNIT I

CMOS OPAMP Circuits:

Module 1 : CMOS models for analog circuits - Small signal equivalent circuit, temperature effect and sensitivity, overview of electrical noise. Analog sub-circuits : CMOS switch, resistors, current source, sink, current mirror, voltage and current references.

Module 2 : CMOS Amplifiers & CMOS Operation Amplifiers : Basic concepts , Performance Parameters , Single Stage OPAMP, Two stage OPAMP, Stability and Phase compensation, Cascade OPAMP

Module 3: Comparators: Characterisation, Two stage open loop comparators, Discrete time comparators , high speed comparator circuits , CMOS S/H circuits

UNIT II

Module 4 : RF Analog Circuits & Sub-circuits

Capacitors and Inductor s in VLSI circuits , Bandwidth estimation techniques, Design of high frequency amplifiers , Design of low noise amplifiers ,Design of Mixers of RF power amplifiers , Architectures of RF receivers and transmitters.

Module 5 : Data Converter Fundamentals & Architecture

Ideal D/A converters, Ideal A/D converter, Serial and Flash D/A converters and A/D converters, Medium and High Speed converters, Over-sampling converters, performance limitations, Design considerations.

Module 6: Special Circuits

Switched Capacitor circuits: General considerations, Resistor simulation using different Switched Capacitor topologies, Switched Capacitor integrators, First and second order switched capacitor filter circuits.; CMOS voltage controlled oscillators, Phase locked loops, Ring oscillators.

TEXT BOOKS:

1. Philip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design". Oxford University Press, International 2nd Edition/Indian Edition. 2010.
2. Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer, "Analysis and Design of Analog Integrated Circuits". Wiley India, 5th Edition, 2010.

REFERENCE BOOKS:

1. David A. Johns. Ken Martin, "Analog Integrated Circuit Design", Wiley Student Edition, 2013.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits". TMH Edition.
3. Baker, Li and Boyce. "CMOS: Circuit Design, Layout and Simulation", PHI.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2244 **(3Th+1T hrs/week)**

Nanoelectronics and Nanomaterials (Elective IV)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: The course aims to introduce Nanotechnology to the students, to provide basic concepts of the Nanomaterials, Nanoelectronic Devices, tools used for Nanoscale Engineering and review the processing methods at Nanoscale.

Pre-requisites: Basic concept of semiconductors and other materials, nano-scale device physics and concepts.

UNIT – I

Introduction to Nanotechnology : Fundamental Concepts of Nanotechnology; Introduction to Modern Nanoscale Devices and Advanced Nanomaterials; Electrical conduction and Ohm's Law; Concepts of Quantum mechanics and Quantum effects in low-dimensional devices.

Effects of Nanoscale systems : Changes to the system total energy; Changes to the system structure; Effects of Nanoscale dimensions on device properties; Particle (Quantum) Nature of Matter: Photon, Electron, Atoms and Molecules.

Nanostructure & Nanoelectronics : Types of nanostructures: Nanowires, Nanocircuits, Quantum Wire, Quantum Well, Quantum Dot; Quantum confinement in semiconductors; Quantum dots production; Application of quantum dots.

UNIT – II

Nanomaterials : Fundamental concepts of Nanomaterials; Materials used in Nanotechnology; Allotropes of Carbon: Aggregated Diamond Nanorods, Graphene, Graphene Nanoribbons, Fullerenes (Buckyballs, C-60), Carbon Nanotubes (CNTs); Classification, properties and characterization of Nanoparticles and Nanocomposites.

Nanoengineering : Nanomotor; Nanopore; Nanosensor; Fabrication and analytical tools processes: Chemical Vapour Deposition (CVD); Lithography; Ion-beam Sputtering; Atomic Force Microscope (AFM); Scanning Tunneling Microscope (STM).

Application of Nanomaterials : Nanoparticle targeting; Neuro-electronic interfaces; Nanorobots; Nano and Microparticles controlled systems.

Computational Nanoelectronics : Introduction to Computational and Modeling Techniques; Computational modelling of molecular mechanics; *Ab Inito* methods; Current Modeling Methods; Molecular Compilers.

Text Books:

1. G. W. Hanson, "*Fundamentals of nanoelectronics*", Pearson, 2009.
2. V. V. Mitin, V. A. Kochelap, M. T. Stroscio,"*Introduction to Nanoelectronics*" 1st edition , Cambridge University Press, 2008.

Reference Books:

1. Ben Streetman and Sanjay Banerjee, *Solid State Electronic Devices, 7e,*Prentice-Hall, 2015.
2. Donald A. Neamen, *Semiconductor Physics And Devices: Basic Principles*, 4e, Tata McGraw-Hill Pvt. Ltd., 2012.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2245 **(3Th+1T hrs/week)**

Cryptography and Network Security (Elective IV)

Question to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : *Any five selecting at least two from each unit.*
Credit : *4 (L-3, T-1, P-0)*

Course objectives:

1. To learn about the threats of network security.
2. To understand what causes these threats by studying how vulnerabilities arise in the development and uses of computer system.
3. To understand the architecture of network security.
4. To narrate and evaluate the design principles of conventional encryption and decryption techniques.
5. To analyze the concepts of public key encryption and public key algorithm.

Pre-requisites: Computer Networks and Number theory.

Course outcomes:

1. Identify and evaluate the major types of threats to information security and the associated attacks.
2. Understand the role of cryptography, the techniques for access control and intrusion detection and write code to encrypt and decrypt information using some of the common cryptographic algorithms.
3. Ability to analyze and determine for any organization the security requirements and appropriate solutions.
4. Ability to protect system from different types of threats, malicious software's vulnerabilities and attacks.
5. Ability to identify ethical, professional responsibilities, risks and liabilities in computer and network environment, and best practices to write security policy.
6. Ability to narrate the Authentication of digital certificates.
7. Ability to differentiate MAC and hashing techniques needed for authentication.

UNIT I

1. Introduction to the Concept of Security: Introduction, The Need of Security, Security Approaches, Principal of Security, Types of Attacks

2. Cryptographic Techniques: Introduction, Plain Text and Cipher Text, Substitution Techniques, Transposition Techniques, Encryption and decryption, Symmetric and Asymmetric Key Cryptography, Steganography, Key Range and Key Size, Possible Types of Attacks

3. Computer-based Symmetric Key Cryptographic Algorithms: Introduction, Algorithm Types and Models, An Overview of Symmetric Key Cryptography, Data Encryption Standard(DES), International Data Encryption Algorithm(IDEA), RC5, Blowfish, Advanced Encryption Standard(AES), Differential and Linear Cryptanalysis

UNIT II

4. Computer-based Asymmetric Key Cryptographic Algorithms: Introduction, Brief History of Asymmetric Key Cryptography, An Overview of Asymmetric Key Cryptography, The RSA Algorithm, Symmetric and Asymmetric Key Cryptography Together, Digital Signatures, Knapsack Algorithm, Some Other Algorithms

5. Public Key Infrastructure (PKI): Introduction, Digital Certificates, Private Key Management, The PKIX Model, Public Key Cryptography standard(PKCS), XML, PKI.

6. Internet Security Protocols and Network Security: Basic Concepts, Security Socket Layer(SSL), Secure Hyper Text Transfer Protocol(SHTTP), Time stamping Protocol(TSP), Secure Electronic Transaction(SET),SSL Versus SET, 3-D Secure Protocol, Electronic Money , Email Security, Wireless Application Protocol(WAP) Security, Security in GSM, Brief Introduction to TCP/IP, Firewalls, IP Security, Virtual Private Networks (VPN)

Text Book:

1. William Stallings, "Cryptography and Network Security", Pearson, 6th Edition.
2. AtulKahate – Cryptography and Network Security , 2nd Edition Tata McGraw Hill Publication, New Delhi-2006

Reference Book:

1. Behrouz A. Forouzan and D. Mukhopadhyay- Cryptography & Network Security, 2nd Edition - 1st reprint 2010, McGraw Hill, New Delhi.
2. Wade Trapple, Lawrence C. Washington- Introduction to Cryptography with coding Theory, 2nd Edition pearson Education.
3. Richard E. Smith, "Internet Cryptography", Pearson, 1st Edition

<u>**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**</u>

EC 2251 **(3Th+1T hrs/week)**

Software Defined Networks (Elective V)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objective: A paradigm shift in the use cases of 'mobile broadband' to 'connected smart society' in the form of IoT and Smart Cities enabling technologies is noticed by the society. Three enabling technologies using the LTE and 5G mobile are i)eMBB ii)MTC and iii)URLLC. The more flexibilities in both the Network as well as Physical layers are being introduced in the heterogeneous network (HetNet) in the name of Cloud RAN, SON and SDN. The Mobile Service Providers all over the world including India are engaged in this technological evolution by implementing all the above.

The course is intended to give students a clear idea of the above technologies. The Unit I will discuss the generic technology overview of individual technology whereas, in Unit II, the individual technologies are combined together to have the idea of total system. Thus the integrated system is aiming for the final enriched experience of the user in high speed GIGABIT internet access using a combined 4G /5G mobile.

Pre-requisites: Digital Communication, Computer Networks.

UNIT – I

1. Cloud RAN

Cloud RAN (C-RAN) Basics, Architecture Components, System Structures, Advantages of C-RAN, Virtualization in C-RAN, Network Functional Virtualization in C-RAN, Challenges of C-RAN.

2. Software Defined Network

History and Evolution of Software Defined Networking (SDN), Overview of Control Plane and Data Plane, Active Networking, Open Flow protocol, Concept of Network Virtualization, implementation using SDN.

UNIT – II

3. Adaptive SON and Smart LPN for 5G Heterogeneous Networks:

Introduction to Self-organization network, Need of Self-organization ,
Cognitive Radio and Compressed Sensing, Compressed Sensing Background, Compressed

Sensing of Analog Signal, Parallele Segmented Compressed Sensing Structure (PSCS), Joint Signal Reconstruction, Simulation Example.

Channel Modelling:
Software Designed Cloud Data Center Simulation –Goals and Requirements, Framework Design---Cloud Sim Core Logic, Abstracting Physical and virtual Topology, Network Modules, Calculating packet Transmission Time, Abstracting User Requests, GUI Modules, Validation with Mininet Setup, Testbed Configuration. Introduction to Smart Low power node.

4. Intelligent SDN and NFV for 5G HetNet Dynamics

Envision of 5G Mobile Networks, Overview of Heterogeneous Networks
5G Mobile Design Principles, Key Technological Components, Spectrum Consideration, Intelligent SDN Architecture for 5G HetNets, New T Mobile 5G advantage, Radio Resource and Interference Management for Heterogeneous Networks, Capacity and Coverage Enhancement in Heterogeneous Networks , Advanced Heterogeneous Networks.
Necessary Standard Extensions for Enabling 5G:
Preliminaries of Network Function Virtualization (NVF), Software Defined radio (SDR), Software Defined Network (SDN) and an integrated 4G/5G Network architecture, Current Standardization Progress on NVF, SDR, SDN. Requirements of 4G/5G NVF, SDR, SDN, Existing Standard and necessary Extension for NVF, SDR, SDN Enabled Network, Necessary Standard Extension for 4G/5G Network.

5. Case Study of a HETNET

Text Books

1. Thomas D. Nadeau, Ken Gray,*SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies*, Thomas D Nadeau, Ken Gray, O'Reilly Media, August 2013, ISBN: 978-1-4493-4230-2, ISBN 10:1-4493-4230-2.

2. Software Defined Networks: A Comprehensive Approach By Paul Goransson, Chuck Black.

3. SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies, Book by Ken Gray and Tom Nadeau.

4. HrishikeshVenkatarman and Ramona Trestian, *5G Radio Access Networks: Centralized RAN, Cloud-RAN, and Virtualization of Small Cells*, CRC Press, 2017.

5. Bo Rong (et.al.) *5G Heterogeneous Networks Self-organizing and Optimization*, Springer, 2016.

Reference Books

1. Fei Hu, Network Innovation through OpenFlow and SDN: Principles and Design, CRC Press, ISBN-10: 1466572094, 2014.

2. Paul Goransson and Chuck Black, Morgan Kaufmann,*Software Defined Networks: A Comprehensive Approach*, June 2014, Print Book ISBN: 9780124166752, eBook ISBN : 9780124166844

3. Tony Q. S. Quek(et.al.), *Cloud Radio Access Networks: Principles, Technologies, and Applications*, 1e, Cambridge University Press, 2017.

EC 2252 **(3Th+1T hrs/week)**

High Speed Digital Design (Elective-V)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objectives: To update the systems towards fully digital systems.
To enable the designer towards digital era. After completion, students will be in a position for designing and analyzing the high speed digital system.

Pre-requisites: Students should have previous knowledge of basic digital system design

UNIT -I

1. NON IDEAL EFFECTS

Basic Transmission line theory and terminology with specific digital focus , crosstalk effects and their relevance to digital timings and explore non ideal transmission line effects, impacts of chip packages, vias, connectors, interconnects and many other aspects that effect the performance of digital system.

2. HIGH- SPEED PROPERTIES OF LOGIC GATES

Brief introduction, Power: introduction, quiescent verses active dissipation, active power when driving a capacitive load, active power due to overlapping bias currents, input power, internal dissipation and output dissipation. Speed: introduction, effects of sudden change in voltage, effects of sudden change in current, and the bottom line-voltage margins.

UNIT -II

3. TERMINATIONS

Introduction, end terminators: rise time of an end terminator, and DC biasing of end terminator. Source terminators: introduction, resistance value of source termination and drive required by source termination. Middle terminators. Crosstalk in terminators: introduction, crosstalk from adjacent axial resistors, crosstalk from adjacent surface-mounted resistors, and crosstalk from SIP terminating resistors.

4. POWER SYSTEMS

Introduction: providing a stable voltage reference. Distributing uniform voltage: introduction, resistance of power distribution wiring, inductance of power distribution wiring and board level filtering. Everyday distribution problems: random ECL errors in a combined TTL-ECL system, too much voltage drop in distribution wiring, power glitches when plugging in cards and EMI radiating from the power distribution wiring.

TEXT BOOK:

1. Howard Johnson & Martin Graham "High Speed Digital Design: A Handbook of Black Magic", 2e , Pearson Education, 2004.

EC 2253 **(3Th+1T hrs/week)**

VLSI Fabrication Technology (Elective-V)

Questions to be set	*: Eight (Four from each unit).Each question carries 20 marks.*
Questions to be answered	*: Any five selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Objectives: This course deals with numerical and analytical as well as experimental study of electro chemical processes used in the fabrication of large scale integrated devices along with Microelectronics Technology. All detailed basics required are covered

Pre-requisites: Basic knowledge in microelectronics, inorganic chemistry and different type of electro chemical process.

UNIT-I

1. Clean room technology - Clean room concept – Growth of single crystal Si, surface contamination, cleaning & etching. (Laboratory Practices: Cleaning of p-type & n-type Si-wafer by solvent method & RCA cleaning)

2.Oxidation – Growth mechanism and kinetic oxidation, oxidation techniques and systems, oxide properties, oxide induced defects, characterization of oxide films, Use of thermal oxide and CVD oxide; growth and properties of dry and wet oxide, do pant distribution, oxide quality; (Laboratory Practices : Fabrication of MOS capacitor).

3. Solid State Diffusion –Flick's equation, atomic diffusion mechanisms, measurement techniques, diffusion in poly-silicon and silicon di-oxide diffusion systems.

4. Ion implantation – Range theory, Equipments, annealing, shallow junction, high energy implementation.

UNIT-II

1. Lithography – Optical lithography, Some Advanced lithographic techniques. Physical Vapor Deposition – APCVD, Plasma CVD, MOCVD.

2. Metallization - Different types of metallization, uses & desired properties. (Laboratory Practices: Metallization &Schottky diode fabrication)

3. VLSI Process integration.

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Text books:

1. Semiconductor Devices Physics and Technology, Author: Sze, S.M.; Notes: Wiley, 1985

2. An Introduction to Semiconductor Micro-technology, Author: Morgan, D.V., and Board, K

Reference books:

1. The National Technology Roadmap for Semiconductors, Notes: Semiconductors Industry Association,SIA, 1994

2. Electrical and Electronic Engineering Series VLSI Technology, Author: Sze, S.M. Notes: Mcgraw-HillInternational Editions.

EC 2254 **(3Th+1T hrs/week)**

Radar Systems and Signal Processing (Elective-V)

Questions to be set : *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered : Any five selecting at least two from each unit.

Course Objective:
1. To understand matched filter.
2. Detection of Radar signals in noise.
3. Radar waveforms.
4. Pulse compression techniques.

Course Outcomes:
1. Design Radar systems specially Automotive radar in different noise environment.
2. Detection of targets in noise environment.
3. This course provides foundation for more advanced work in detection theory adaptive signal processing.

Pre-requisites: Analog and digital communication systems, DSP

UNIT – I
A: GENERALIZED RADAR Framework

1. **Range equation & matched filter [5]**

Radar Block Diagram, Radar Equation, Information Available from Radar Echo, Radar Range Performance– General Radar Range Equation, Radar Detection with Noise Jamming, Beacon and Repeater Equations, Bi-static Radar.

Matched filter Receiver – Impulse Response Frequency Response Characteristic and its Derivation, Matched Filter and Correlation Function, Correlation Detection and Cross-Correlation Receiver. Efficiency of Non-Matched Filters, Matched Filter for Non-White Noise.

2. **Signal models [2]**

Amplitude model: Radar cross section, Statistical description,
Clutter: Noise model, Signal to Noise ratio, jamming.
Frequency models: Doppler shift
Spatial Models: Variation with angel cross range multipath

3. **Sampling and quantization of pulsed radar signals [7]**

Domain criteria for sampling radar signals , sampling in the fast time dimension ,Sampling in slow time ,Sampling the Doppler spectrum, spatial and angel dimension ,Quantization.

Radar Waveforms: Waveform Matched filter of moving targets Ambiguity function, Pulse burst Waveforms.

Frequency Modulated pulse compression wave forms: Introduction, significance, Types:

Linear FM Pulse Compression – Block Diagram, Characteristics reduction of Side lobes, Stretch Techniques. Generation and decoding of FM Waveforms-block, schematic and characteristics of passive system, digital compression.

4. **Doppler processing [3]**

Moving Target Indication: Pulse cancellers, matched filters for clutter suppression, Blind speeds Pulse Doppler processing: DFT of moving targets, Sampling of DTFT, Fine Doppler estimation. Pulse pair processing .

Detection Fundamentals: Neynan-Pearson Detection Rule, Threshold Detection of radar signals

5. **Phase coding techniques [3]**

Principles, Binary Phase Coding, Barker Codes, Maximal Length Sequences (MLS/LRS/PN), Block Diagram of a Phase Coded CW Radar. Linear FM and Frequency Coding Techniques: Principles, Linear FM pulses, Generation and Decoding, Distortion effects on LFM Signals, Discrete Frequencies, Waveform Analysis, Capabilities, Resolution properties of Frequency Coded Pulses,

Poly Phase Codes: Frank Codes, Costas Codes, Non-Linear FM Pulse Compression, Doppler Tolerant PC Waveforms – Short Pulse, Linear Period Modulation (LPM/HFM). Side lobe Reduction for Phase Coded PC Signals.

UNIT – II

B: AUTOMOTIVE RADAR Framework

6. **Automotive Radar Reviews [4]**
   Introduction, Automotive radar classification, Basic automotive radar estimation problems: Range estimation, Velocity estimation, Direction estimation
   Radar waveforms, Advanced estimation techniques: ML estimation, Super resolution techniques, MIMO radar, Target tracking problem
7. **Automotive Radar Target Tracking by Kalman Filtering [2]**
   Introduction, signal processing structure, experimental results,
8. **Automotive Radars: System-Level Considerations [2]**
   Automotive Radar Spectra, Ultra-Wideband Radar Architectures, Radar System-Level Specifications
9. **A 22–29-GHz UWB Pulse-Radar Receiver Front-End [3]**
   Receiver Architecture , Circuit Design, 22–29-GHz UWB Neutralized LNA, Quadrature Mixers and Baseband VGAs, Pulse Formation, Measurement Results
10. **Single-Chip Dual-Band 22–29-GHz/77–81-GHz [3]**
    BiCMOSTransceiver , Dual-Band Transceiver Architecture , Transceiver Implementation, Receiver, Transmitter, Dual-Band Frequency Synthesizer, Baseband Pulse Generator, Measurement Results
11. **Case Study [6]** ARTRAC Project, Advanced Radar Tracking and Classification for Enhanced Road Safety:- THE ARTRAC SENSOR and THE ARTRAC ARCHITECTURE, Report on demonstrations of ARTRAC vehicles.

Text Books:

[1]Mark. A. Richards, "Fundamentals of Radar Signal Processing", TMH, 2005.
[2] https://ieeexplore.ieee.org/document/7870764
[3] https://ieeexplore.ieee.org/document/6704439
[4] Vipul Jain · Payam Heydari, "Automotive Radar Sensors in Silicon Technologies", Springer Science + Business Media New York 2013.
[5] http://artrac.tutech.eu/index.php/page/Documents-2012-04-05.html

References:

[1]Fred E. Nathanson, "Radar Design Principles: Signal Processing and the Environment", 2nd ed., PHI, 1999.

[2]Peyton Z. Peebles Jr, "Radar Principles", John Wiley, 2004.

[3]R. Nitzberg, "Radar Signal Processing and Adaptive Systems", Artech House, 1999.

[4]F.E. Nathanson, "Radar Design Principles", 1st ed., McGraw Hill, 1969.

[5]M.I. Skolnik, "Introduction to Radar Systems", 3rd ed., TMH, 2001.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2255 **(3Th+1T hrs/week)**

Satellite and Optical Communication Systems (Elective V)

Question to be set	*: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered	*: Any five, selecting at least two from each unit.*
Credit	*: 4 (L-3, T-1, P-0)*

Course Objectives:

The major issue in modern day communication is the enhanced data rate. The principal objective of this course is to provide the knowledge of high data rate communication. The optical communication offers up to 100Gbps data rate while the satellite communication is the only competitor of optical communication in wireless domain. Thus this course is designed from basics to the advanced applications of satellite as well as optical communication.

Pre-requisites: Students should have previous knowledge of digital communication, broad band communication , microwave engineering and optoelectronics.

UNIT-I

1. **Review of Satellite Communication:**
   Introduction to satellite communication systems, Orbital Mechanics & Launchers, Spacecraft subsystems, AOCS, TT&C, Transponders, Space Craft antennas, Equipment reliability, Earth Station technology.

2. **Indian National Satellite System:** ISRO projects on satellite communications, INSAT, GSLV, EDUSAT, case studies.

3. **Direct Video Broadcasting:**
   DTH technology, comparison with Cable TV system, DTH satellites, DVB-S and DVB-S2, case studies.

UNIT-II

4. **Satellite in Remote Sensing:**
   Global positioning system (GPS), Triangulation, introduction to GIS, case studies.

5. **Inter-satellite link:**
   Types of Inter-satellite link, Crisis in X-band, Optical Inter-satellite link (OISL).

6. **Review of Optical Fibre:**
   Core, cladding, numerical aperture, modes, step and graded index fibre, group delay and mode delay factor, optical sources, coupling of optical fibre.

7. **Application of Optical Fibre:**
High speed communication, Biomedical Endoscopy, Military applications, case studies.

Text Books:

1. Pratt, Bostian, "Satellite Communications" 2e John wiley & Sons- 2002.

2. John Senior, "Optical Fiber Communications", 2e Edition, PHI, 1992

3. Gred Keiser, "Optical Fiber Communications 3/e", McGraw Hill, 2000.

Reference:

1. Book: John Gowar: Optical Communication Systems (2nd Ed.), Prentice Hall, 1993.

2.Report: De Carlo et al., "Inter-satellite link for Earth Observation Satellites constellation", American Institute of Aeronautics and Astronautics

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2261 **(3 Hrs/Week)**

Advanced DSP Laboratory

Credit : 1.5 (0L+0T+3P hrs/week)
Minimum No. of Experiments to be carried out: 12.

Course Objective : The principal objective of this lab is to provide the students a hands-on exposure to the MATLAB and DSP Processors. Students will be able to implement various signal processing task using MATLAB and real time DSP processors.

Pre-requisites: Digital signal processing

List of Experiments

1. **Design of IIR filters**
2. **Design of FIR filters**
3. **Up sampling and Down sampling**
   - a) Input-output relation in the Time-Domain
   - b) Input-output relation in the Frequency-Domain.
4. **Decimator And Interpolator Design and Implementation**
   - a) Decimator Design and Implementation
   - b) Interpolator Design and Implementation
5. **Simulation of Zero forcing equalizer**
6. **Noise cancellation using LMS and RLS Algorithms**
7. **Channel Equalization using LMS algorithm.**
8. **Non-Stationary Nature of Speech Signal**
   - a) To understand the difference between stationary and non-stationary signal
   - b) To get feel about the non stationary nature of speech signal
   - c) To understand the limitations of Fourier transform in case of non-stationary signals
9. **Identification of Voice/Unvoiced/Silence regions of Speech**
   - a) To understand about the time and frequency domain characteristics of voiced speech.
   - b) To understand about the time and frequency domain characteristics of unvoiced speech.

c) To learn to perform the voiced/unvoiced/silence classification of speech

10. **Short Term Time domain Processing of Speech**

a) To understand need for short term processing of speech.
b) To compute short term energy and study its significance.
c) To compute short term zero crossing rate and study its significance.
d) To compute short term autocorrelation and study its significance.
e) To estimate pitch of speech using short term autocorrelation.
f) To perform voiced/unvoiced/silence classification of speech using short term time domain parameters.

11. **Short Term Frequency domain Processing of Speech**

a) To understand the limitation of DTFT for the spectral analysis of speech.
b) To understand the development of short-term Fourier transform(STFT) representation.
c) To understand the difference in the nature of linear and log magnitude spectra.
d) To understand the difference among the spectra of voiced, unvoiced and silence regions of speech.
e) To plot the STFT of a speech signal.
f) To understand the difference between true and convolved spectra.
g) To understand the effect of rectangular Hamming and Hanning window functions on short term spectral analysis.
i) To understand the effect of frame size on short term spectral analysis

12. **Quantization of a color Lena Image.**

13. **Implement Huffman coding to encode the message "go go gophers".**

14. **Application of DCT and DWT on a Lena Image.**

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC 2262 **(3 hrs/week)**

IoT Laboratory

Credit: 1.5 (0L+0T+3P hrs/week)
Minimum No. of Experiments to be carried out: 12.

Course Objective: To familiarize the student with Arduino, Rasberry Pi, and Node MCU Embedded Hardware platform and related software platform. To encourage student to take real life project related to home automation, security system etc

Pre-requisites: Analog and Digital Communication, Basic microcontroller programming skills, C programming, Basic knowledge about sensors.

List of Experiments:

1. Familiarization with different IoT Embedded Hardware and Software platform
2. Interfacing different sensors with Arduino Embedded Hardware
3. Interfacing different sensors with Node MCU Embedded Hardware
4. Interfacing different sensors with Rasberry Pi Embedded Hardware
5. Interfacing ESP8266, Bluetooth module, WiFi module with Ardunio Nano for Two way communication
6. Voice and Finger print controlled IoT end device development.
7. To upload weather data to ThingSpeak channel through Raspberry pi.
8. ESP8266 Interfacing with ARM7-LPC2148- Creating a Webserver to control a Home appliance
9. Development of Home security system based on camera and motion sensors
10. Incorporating different encryption technique for IoT.
11. Android App development
12. Project work: Design and development of IoT enabled Home automation system.

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Established under Govt. of Sikkim, Act 9 of 1995, recognised under 2(f) of the UGC Act, 1956

OFFICE ORDER

MODIFICATION IN THE SYLLABI OF M.TECH IN DECE, SMIT

1. The Academic Senate of the University in its 55th Meeting held on 15 June 2019 has approved the major modification in the curriculum and syllabi of M.Tech Digital Electronics & Communication Engineering (DECE) from 2019 admitted batch onwards

2. **Change in name of Lab**

Present			Proposed	
Sl No.	Sub. Name	Sub. Code	Sub. Name	Sub. Code
1	Communication Laboratory II	EC 2262	IoT Laboratory	EC 2262

3. **Change in Schema**

		Present Schema		Proposed Schema	
Sl No.	Semester	No of Core Subjects	No of Elective Subjects	No of Core Subjects	No of Elective Subjects
1	I	4	1	3	2
2	II	4	1	2	3

4. The details of present and proposed courses for core and elective subjects introduced in different semester of M.Tech Digital Electronics & Communication Engineering are as follows:

I Semester

Present Schema		Proposed Schema	
MA 2109	Probability, Statistics and Random Process	MA 2109	Probability, Statistics and Random Process
EC 2101	Information Theory and Coding	EC 2101	Information Theory and Coding
EC 2102	4G Technologies and beyond	EC 2102	VLSI Design
EC 2103	Applied Electromagnetics	EC 21**	Elective-I
EC 21**	Elective-I	EC 21**	Elective-II
EC 2161	VLSI Laboratory	EC 2161	VLSI Laboratory
EC 2162	Communication Laboratory –I	EC 2162	Communication Laboratory
EC 2181	Seminar-I	EC 2181	Seminar-I

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