# Syllabus for
M.Tech in Electronics & Communication Engineering & Electronics & Telecommunication Engineering

<table>
<thead>
<tr>
<th>Semester</th>
<th>Subject</th>
<th>Credit</th>
<th>Details of Subjects</th>
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<tbody>
<tr>
<td>I</td>
<td>PC-1</td>
<td>4</td>
<td>Modern Digital Communication Techniques</td>
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<tr>
<td></td>
<td>PC-2</td>
<td>4</td>
<td>Information Theory, Coding and Cryptography</td>
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<tr>
<td></td>
<td>PC-3</td>
<td>4</td>
<td>Telecommunication Switching and Networks</td>
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<tr>
<td></td>
<td>EL-1</td>
<td>3</td>
<td>Adaptive Signal Processing</td>
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<tr>
<td></td>
<td><strong>(any one)</strong></td>
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<td>Satellite Communication System</td>
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<td>Digital Integrated Circuit Design</td>
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<td></td>
<td>Mathematics for Communication Engineering</td>
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<td></td>
<td>EL-2</td>
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<td>Fiber-Optics Components and Devices</td>
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<tr>
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<td>Computational Intelligence</td>
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<td>Semiconductor Device Modeling and Simulation</td>
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<td>Communication System Engineering Lab</td>
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<td>II</td>
<td>PC-4</td>
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<td>Microwave and Antenna Engineering</td>
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<td>PC-5</td>
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<td>Wireless Communication</td>
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<td></td>
<td>EL-3</td>
<td>3</td>
<td>Statistical Signal Processing</td>
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<td>Digital Speech Processing</td>
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<td>Biomedical Instrumentation and Signal Processing</td>
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<td>EL-4</td>
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<td>Optical Communication</td>
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<td>Wireless Sensor Network</td>
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<td>RF and Mixed Signal Integrated Circuit Design</td>
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<td>Industrial Telematics</td>
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<td>EL-5</td>
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<td>Embedded System Design</td>
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<td>Mobile Computing</td>
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<td>Internet and Web Technology</td>
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<td>Lab-2</td>
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<td>Design and Simulation Lab</td>
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<td>Seminar on Pre-thesis work-2</td>
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<td>Comprehensive Viva-Voce - I</td>
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<td>III</td>
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<td>Project Management / Project Costing / Technology Management / Research Methodology / Optimization Techniques / / Thesis – I</td>
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<td>Seminar</td>
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<td>Comprehensive Viva-Voce – II</td>
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<td><strong>Total Credits</strong></td>
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Module 1: (12 hrs)

**Deterministic & Random Signal Analysis**

**Module 2: (18 hrs)**

**Digital Modulation Scheme**

**Optimum Receivers for AWGN Channels**
Waveform and Vector Channel Models; Optimum Detection for a General Vector Channel. Waveform and Vector AWGN Channels; Optimal Detection for the Vector AWGN Channel, Implementation of the Optima Receiver for the AWGN Channels. Optimal Detection and Error Probability for ASK, PAM,PSK AND QAM Signaling. [Proakis & Salehi Sections 4.1-1, 4.2-1,4.2-2, 4.3-1, 4.3-2, 4.3-3]

**Carrier and Symbol Synchronization**

**Module 3: (15 hrs)**

**Digital Communication Through Band-Limited Channels**

**Multichannel and Multicarrier Systems**

**Spread Spectrum Signals for Digital Communication**

**Text Book**

**Reference Books**
1. Simon Haykin, *Digital Communication*, Willy
Information Theory, Coding and Cryptography (3-1-0) Credit : 4

Module: 1 12 Hours

Source Coding
Introduction to information theory, uncertainty of information, Information measure, entropy, source coding Theorem, Huffman Coding, runlength encoding, rate distortion function, JPEG and MPEG standards in image compression.

Channel Capacity and Coding
Channel models, Channel Capacity, Channel Coding, Information Capacity Theorem, The Shannon Limit.

Module: 2 14 Hours

Error Control Coding
Linear Block Codes: Introduction, Basic definition, equivalent codes, parity - check matrix, decoding, syndrome decoding, Perfect Codes, Hamming Codes, Optimal Linear codes.

Cyclic Codes
Introduction polynomials, The division Algorithm, Method for generating cyclic codes, Burst Error correction, Fire Codes, Golay Codes, CRC Codes, Circuit implementation.

Bose Chaudhuri Hocquenghem (BCH)
Introduction, Primitive elements, minimum polynomials, Examples of BCH codes, Decoding of BCH codes, Recd - Solomon codes.

Module: 3 14 Hours

Convolution Codes
Introduction, Tree Codes and Trellis Codes, Polynomial description, The Generating function, Matrix Description, Viterbi Decoding, Distance bounds, Turbo Codes, Turbo Decoding.

Trellis Coded Modulation (TCM)
Introduction, the concept of coded modulation, Mapping by set Partitioning, Design rules, TCM Decoder.

Coding for Secure Communication, Cryptography
Introduction, encryption techniques, Symmetric cryptography, data encryption standard, Asymmetric Algorithm the RSA Algorithm.

Textbooks:


Recommended Reading:


Telecommunication Switching and Networks  

MODULE – I  

Introduction  
Evolution, simple telephone communication, basis of switching system, telecommunication networks.  

Electronic space division switching  
Stored program control, centralized and distributed SPC, software architecture, application software, enhanced software, two and three stage networks.  

Time Division Switching  
Basic time division space switching, basic time division time switching, time multiplexed space and time switching, combination switching, three-stage combination switching.  

MODULE – II  

Traffic Engineering  
Network traffic load and parameters, Grade of service, modelling switching systems, incoming traffic, blocking models and loss estimates.  

Telephone Networks  
Subscriber loop systems, switching hierarchy and routing, transmission plan, transmission systems, signalling techniques  

MODULE – III  

Data Networks  
Data transmission in PSTN, switching techniques, Data communication architecture, link-to-link layers, end-to-end layers, satellite based data networks, LAN, MAN, Fibre optic networks, an overview of data network standards  
Integrated Service Digital Network, motivation, new services, transmission channels, signalling, service characterization, ISDN standards, broad band ISDN, voice data integration.  

Textbooks:  

Recommended Reading:  
1. 
MODULE – I  
Adaptive System  
Definition and Characteristics, Areas of Application, Example of an Adaptive System, Adaptive Linear Combiner, The Performance Function, Gradient and Minimum Mean-Square Error, Alternative Expression of the Gradient, Decorrelation of Error and Input Components. [Read Widrow: Chapter 1 and 2]

Winer Filter  
Linear Optimum Filtering, Principle of Orthogonality, Minimum Mean Square Error, Winer-Hopf Equation, Error Performance Surface. [Read Haykin: Chapter 2.1-2.5]

Linear Prediction  
Forward Linear Prediction, Backward Linear Prediction, Properties of Prediction Error Filters. [Read Haykin: Chapter 3.1, 3.2, 3.4]

MODULE – II  
Method of Steepest Descent  
Basic Idea of Steepest-Descent Algorithm, Steepest-Descent Algorithm Applied to Winer Filter, Stability of Steepest-Descent Algorithm, Limitations of Steepest-Descent Algorithm. [Read Haykin: Chapter 4.1 – 4.3, 4.6]

Least-Mean Square Adaptive Filter  
Overview, LMS Adaptation Algorithm, Application, Comparison of LMS With Steepest-Descent Algorithm. [Read Haykin: Chapter 5.1 – 5.3, 5.5]

Normalized Least-Mean Square Adaptive Filter  
Normalized LMS Filter as the Solution to Constrained Optimization Problem, Stability of the NLMS. [Read Haykin: Chapter 6.1, 6.2]

MODULE – III  
Frequency-Domain and Subband Adaptive Filters  
Block Adaptive Filters [Read Haykin: Chapter 7.1]

RLS Adaptive Filters  
Statement of Linear Least-Square Estimation Problem, Matrix Inversion Lemma, The Exponentially Weighted RLS Algorithm. [Read Haykin: Chapter 8.1, 9.1 – 9.3]

Kalman Filter  
Recursive Minimum Mean-Square Estimation For Scalar Random Variable, Kalman Filtering Problem, Initial Conditions, Summary of Kalman Filter. [Read Haykin: Chapter 10.1, 10.2, 10.6, 10.7]

Textbooks:

Recommended Reading:
1.
Module: 1  13 Hours

Satellite Communication Technology

Satellite orbits, Satellite constellation and ISL, orbital parameters, look angle determination, launching procedures. Spacecraft subsystems - Attitude and orbit control, power, TT & C, communication and antennas. Earth station design - Digital transmitter and receiver, antenna and beam steering techniques.

Module: 2  13 Hours

Link Design

Digital satellite link analysis and design for FSS and BSS - link budget and Eb/No calculations. Performance impairments - Noise, interference, propagation effects and frequency considerations.

Module: 3  14 Hours

Access Techniques

FDMA concept- Intermodulation and back off - SPADE system. TDMA concept - Frame and burst structure - Frame acquisition and synchronization - Satellite Switched TDMA system. CDMA concepts - DS and FH System acquisition and Tracking.

Audio broadcasting via satellite – World Space Services through Teledesic, LEO system and Glob star.

Textbooks:


Recommended Reading:

MODULE – I (11 hours)

Introduction, Design Metrics and Manufacturing Process:

The Devices:

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, Ratioed Logic, Pass-Transistor Logic

CMOS Inverter – the Dynamic View:

MODULE – II (11 hours)

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

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, Nonbistable Sequential Circuits

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

Timing Issues in Digital Circuits:

MODULE – III (12 hours)

Designing Arithmetic Building Blocks:

Designing Memory and Array Structures:
Introduction, The Memory Core, Memory Peripheral Ciruitry, 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

Validation and Test of Manufactured Circuits:
Introduction, Test Procedure, Design for Testability, Test Pattern Generation

Textbooks:

Recommended Reading:
Mathematics for Communication Engineering (3 – 0 – 0) Credits: 3

MODULE – I (11 hours)

Introduction and Foundations:
Markov and hidden Markov Models [Read Moon: 1.7]

Vector Spaces and Linear Algebra:
Metric Spaces, Vector Spaces, Norms and Normed vector Spaces, Inner Products and Inner Product Spaces, Induced Norms, The Cauchy-Schwarz Inequality, Orthogonal Sub Spaces, Projections and Orthogonal Projection, Projection Theorem, Orthogonalization of Vectors. [Read Moon: 2.1 – 2.6, 2.10, 2.13, 2.14, and 1.15]

Representation and Approximation in Vector Spaces:
The Approximation Problem in Hilbert Space, The Orthogonality Principle, Matrix Representation of Least-Squares Problems, Linear Regression, Least Squares Filtering, Minimum Mean Square Estimation, Minimum Mean Squared Error (MMSE) Filtering, Comparison of Least Squares and minimum Mean Squares. [Read Moon: 3.1, 3.2, 3.4, 3.8 - 3.12]

MODULE – II (11 hours)

Some Important Matrix Factorization:
The Cholesky Factorization, Unitary Matrices and the QR Factorization. [Read Moon: 5.2 and 5.3]

The Singular Value Decomposition:
Theory of the SVD, Matrix Structure from the SVD, Pseudo-inverses and the SVD, Rank – Reducing Approximations: Effective Rank, System Identification Using the SVD. [Read Moon: 7.1 – 7.3, and 7.5]

Introduction to Detection and Estimation, and Mathematical Notation:
Detection and Estimation Theory, Some Notational Conventions, Conditional Expectation, Sufficient Statistics, Exponential Families. [Read Moon: 10.1 – 10.3, 10.5, and 10.6]

MODULE – III (11 hours)

Detection Theory:
Introduction to hypothesis testing, Neyman-Pearson theory, Neyman Pearson testing with Composite Binary Hypotheses, Bayes Decision Theory, Some M-ary Problems, Maximum-Likelihood Detection. [Read Moon: 11.1 – 11.6]

Estimation Theory:
The Maximum Likelihood principle, ML Estimates and sufficiency, Applications of ML Estimation, Bayes Estimation Theory, Bayes risk [Read Moon: 12.1 – 12.6]

Textbooks:

Recommended Reading:
1. Probability and Random Processes with Application to Signal Processing, Pearson Education.
MODULE – I

Fibre-Optic Light Sources and Detectors


Brief description on the principle of optical detectors, photodetector noise, Noise sources, Signal-to-Noise ratio, Detector response time, Depletion layer photocurrent, Response time, Avalanche multiplication noise.

MODULE – II

Optical Fibre Connection

Joint loss, Multi mode fibre joints, Singe mode fibre joints, Fibre splices, Fusion splices, Mechanical splices, Multiple splices, Fibre connectors, Cylindrical ferrule connectors, Biconical ferrule connectors, Double eccentric connectors, Duplex fibre connectors, Expanded beam connectors, Fibre couplers, Three port couplers, Four port couplers, Star couplers, WDM couplers.

MODULE – III

Optical Amplification and Integrated Optics


Textbooks:
2. J.M. Senior, *Optical Fibre Communications Principles and Practice*, PHI.

Recommended Reading:
1.


Fuzzy Inference System: Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto fuzzy models, other considerations.

Least Square Method for system Identification: System Identification, Basic of matrix manipulations and calculus, Least-square estimator, Geometric interpretation of LSE, Recursive least-square estimator, Recursive LSE for time varying systems, Statistical Properties and maximum likelihood estimator, LSE for nonlinear models.

Derivative-based optimization: Descent methods, the method of steepest descent, Newton’s methods, Step size determination, conjugate gradient methods, Analysis of quadratic case, nonlinear least-squares problems, Incorporation of stochastic mechanism.

Derivative-free optimization: Genetic algorithm simulated annealing, random search, Downhill simplex search, Swarm Intelligence, genetic programming.

Adaptive Networks: Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule: combing steepest descent and LSE.


Learning from reinforcement: Failure is the surest path to success, temporal difference learning, the art of dynamic programming, Adaptive heuristic critic, Q-learning, A cost path problem, World modeling, other network configurations, Reinforcement learning by evolutionary computations.


Adaptive Neuro-fuzzy inference systems: ANFIS architecture, Hybrid learning algorithms, Learning methods that cross-fertilize ANFIS and RBNF, ANFIS as universal approximator, Simulation examples, Extensions and advance topics.


Books:
**Analogue Integrated Circuit Design**

(3 – 0 – 0) Credits: 3

**MODULE – I**  
(11 hours)

**Introduction:**
The MOS Transistor, I-V Characteristics, Equivalent Circuits, Noise

**Resistor, Capacitors and Switches:**
Integrated Resistors, Integrated Capacitors, Analog Switches, Layout of Switches

**Basic Building Blocks:**
Inverter with Active Load, Cascode, Cascode with Cascode Load, Source Follower, Threshold Independent Level Shift, Improved Output Stages

**MODULE – II**  
(11 hours)

**Current and Voltage Sources:**
Current Mirrors, Current References, Voltage Biasing, Voltage References

**CMOS Operational Amplifiers:**
General Issues, Performance Characteristics, Basic Architecture, Two Stages Amplifier, Frequency Response and Compensation, Slew Rate

**MODULE – III**  
(12 hours)

**Operational Amplifiers and OTAs**
Design of Two Stage OTAs: Guidelines, Single Stage Schemes, Class AB Amplifiers, Fully Differential Op-Amps, Micro-Power OTAs, Noise Analysis, Layout

**CMOS Comparators:**
Performance Characteristics, General Design Issues, Offset Compensation, Latches

**Textbooks:**

**Reference Books:**
Semiconductor Device Modeling and Simulation (3 – 0 – 0) Credits: 3

MODULE – I (11 hours)

Semiconductor Electronics Review:
Elements of Semiconductor Physics, Physical Operation of a PN Junction, MOS Junction, MS Junction

PN–Junction Diode and Schottky Diode:
DC Current-Voltage Characteristics, Static Model, Large-Signal Model, Small-Signal Model, Schottky Diode and its Implementation in SPICE2, Temperature and Area Effects on the Diode Model Parameters, SPICE3, HSPICE and PSPICE Models

Bipolar Junction Transistor (BJT):

MODULE – II (11 hours)

Junction Field-Effect Transistor (JFET):
Static Model, Large-Signal Model and its Implementation in SPICE2, Small-Signal Model and its Implementation in SPICE2, Temperature and Area Effects on the JFET Model Parameters, SPICE3, HSPICE and PSPICE Models

Metal-Oxide-Semiconductor Transistor (MOST):
Structure and Operating Regions of the MOST, LEVEL1 Static Model, LEVEL2 Static Model, LEVEL1 and LEVEL2 Large-Signal Model, LEVEL3 Static Model, LEVEL3 Large-Signal Model, The Effect of Series Resistances, Small-Signal Models, The Effect of Temperature, BSIM1, BSIM2, SPICE3, HSPICE and PSPICE Models

MODULE – III (12 hours)

BJT Parameter Measurements:
Input and Model Parameters, Parameter Measurements

MOST Parameter Measurements:
LEVEL1 Model Parameters, LEVEL2 Model (Long-Channel) Parameters, LEVEL2 Model (Short-Channel) Parameters, LEVEL3 Model Parameters, Measurements of Capacitance, BSIM Model Parameter Extraction

Noise and Distortions:
Noise, Distortion

Metal-Semiconductor Field-Effect Transistor (MESFET), Ion-Sensitive Field-Effect Transistor (ISFET) and Semiconductor-Controlled Rectifier (Thyristor):
The MESFET, The ISFET, The Thyristor

Textbooks:

Recommended Reading: